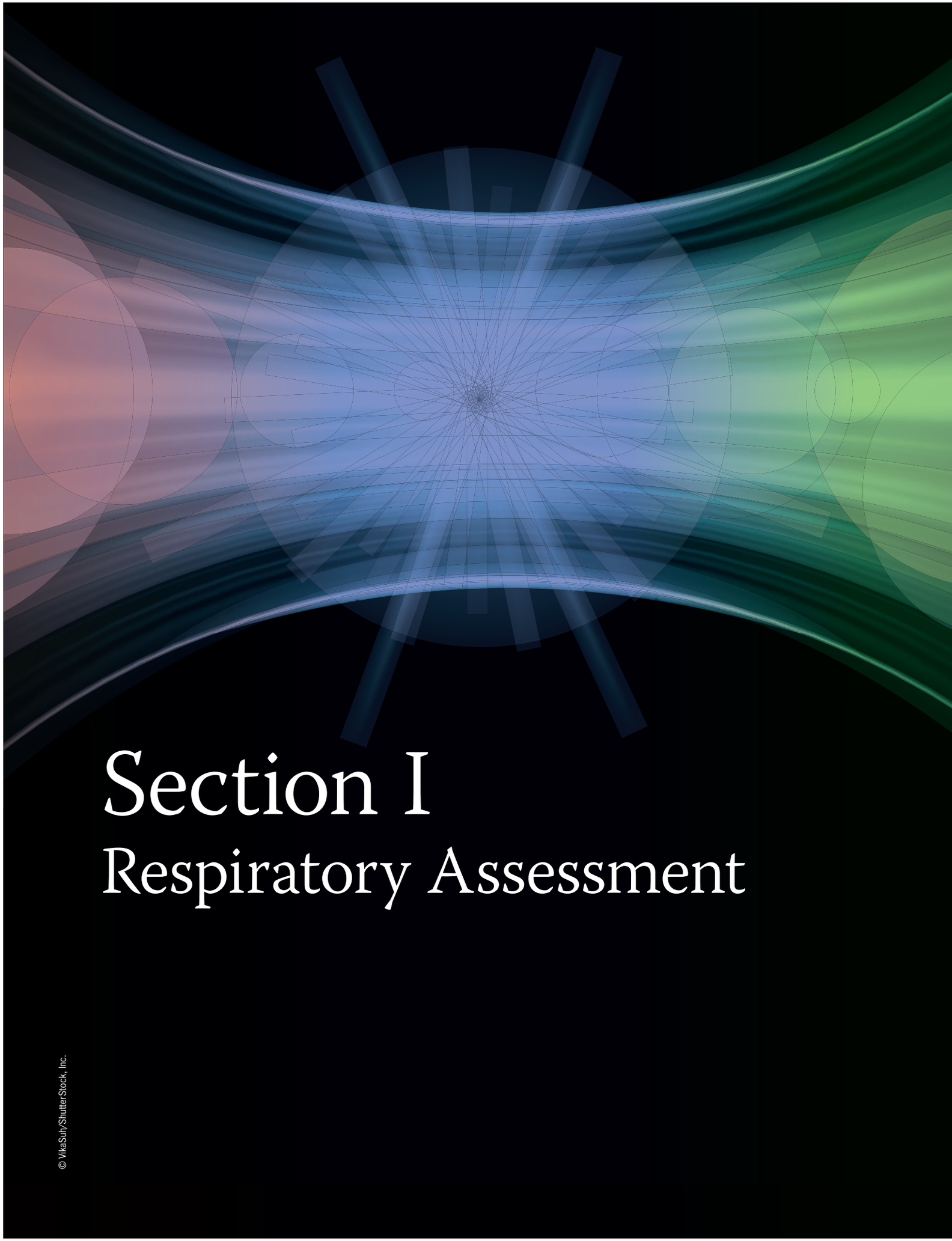
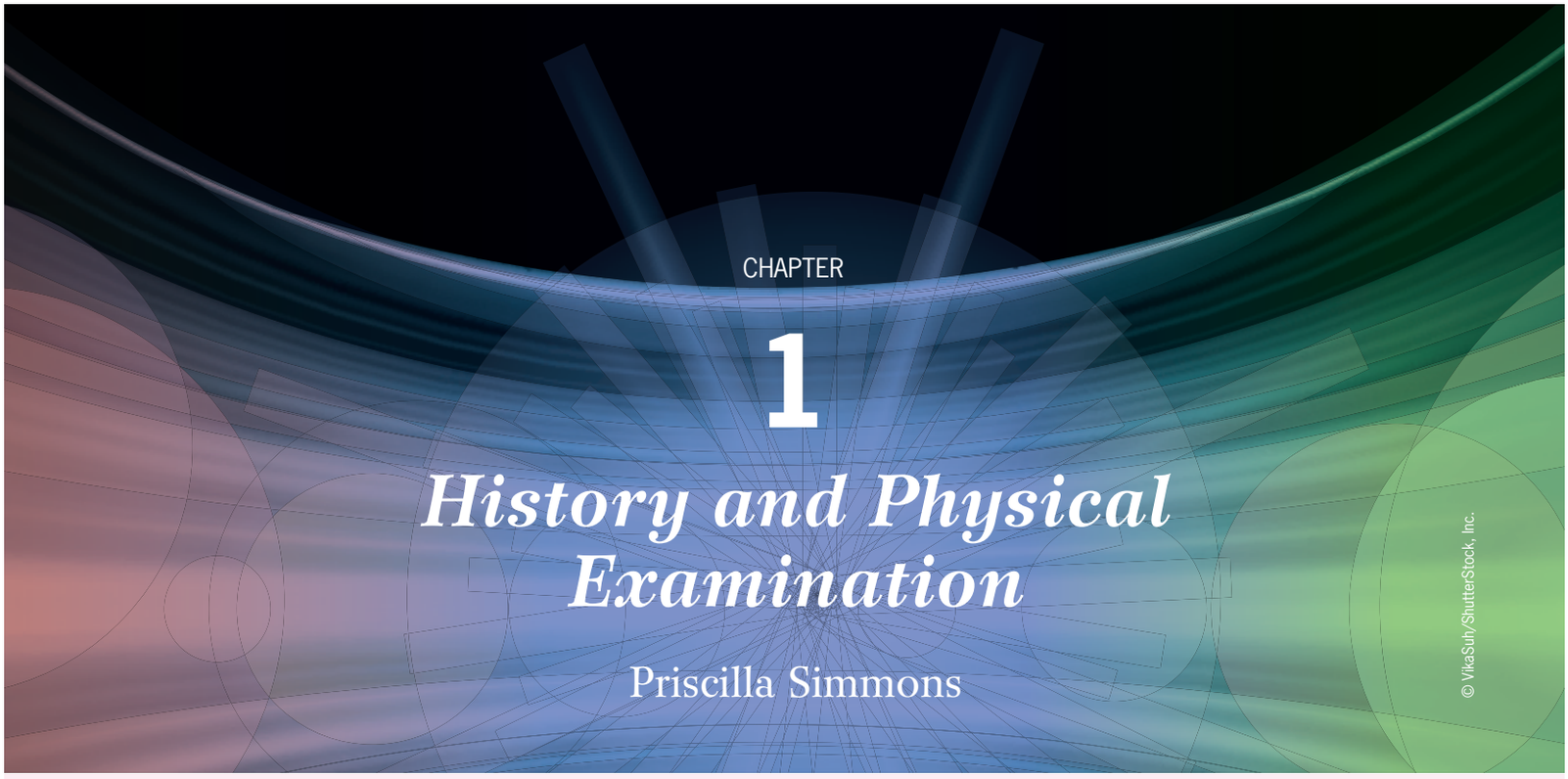


# Section I
# Respiratory Assessment



CHAPTER

# 1

# History and Physical Examination

Priscilla Simmons



## OUTLINE



## OBJECTIVES

1. Discuss the factors essential in the creation of a therapeutic climate.
2. Explain three considerations of an effective health history.
3. Explain the relevance of cultural diversity in the history-taking process.
4. List the major components of a health history.
5. Identify the four major examination techniques.
6. Define common terms used in assessment of the respiratory system.
7. Explain the technique for auscultation of the chest.
8. Define terms associated with normal and abnormal breath sounds.
9. List the signs associated with respiratory distress.
10. Identify common pathologic processes of the respiratory system and pertinent physical findings that extend to other body systems.
11. Identify the significance of various chest landmarks.
12. Explain the significance of sounds heard during cardiac auscultation.
13. Explain the significance of jugular venous distention.
14. Explain common findings associated with an assessment of the neurologic system.

## KEY TERMS

**auscultation**
**barrel chest**
**Biot respirations**
**bradypnea**
**bronchial breath sounds**
**bronchophony**
**bronchovesicular**
**Cheyne-Stokes breathing**
**clubbing**
**crackles**
**cyanosis**
**dyspnea**
**egophony**
**flail chest**
**grunting**
**hyperpnea**
**hyperresonant**
**hyperventilation**
**inspection**
**jaundice**
**Kussmaul respirations**
**kyphosis**
**lordosis**
**murmur**
**orthopnea**
**pack years**
**pallor**
**palpation**
**paradoxical respiration**
**paroxysmal nocturnal dyspnea**
**pectus carinatum**
**pectus excavatum**
**percussion**
**platypnea**
**plethora**
**pleural friction rub**
**precordium**
**resonant**
**rhonchus**
**scoliosis**
**stridor**
**tachypnea**
**tactile fremitus**
**tympanic**
**vesicular breath sounds**
**wheezes**
**whispered pectoriloquy**

## Introduction

This chapter provides a guide to essential assessment techniques used by the respiratory therapist. In the hospital, many members of the healthcare team examine the patient. In the community setting, however,

fewer members of the healthcare team assess the patient, thereby warranting a more thorough examination by the respiratory therapist. Whatever the setting, no clinician regularly uses all the available assessment techniques. Some techniques are rarely used. The emphasis of this chapter is on the pathophysiology underlying common respiratory abnormalities and the typical assessment findings associated with them.

## Creating a Therapeutic Climate

The patient's perception of the respiratory therapist's competence is of prime importance. When any healthcare provider is perceived as uncaring, the patient may remember that attitude most vividly. Even worse, that poor image may come to characterize all the members of the profession for the patient. To ensure a therapeutic, professional relationship, competence and caring must coexist. A clinician can communicate caring through a gentle demeanor and an unhurried, nonabrupt manner. Maintaining eye contact is essential. Also appropriate is the judicious use of touch, such as patting or squeezing a patient's hand or shoulder. Respiratory therapists should dress appropriately because a professional appearance communicates respect for the patient. A patient's judgment of a healthcare provider often is based on physical appearance. These measures help establish rapport and a climate of professional caring, a goal in every professional relationship.

## Components of the Health History

The health history provides a detailed, chronologic health record of the patient's status. For the purpose of developing an individualized plan of care, the health history elicits information about variables affecting the patient's health. The value of the history should not be underestimated because it guides the selection of appropriate physical examination techniques, helps the respiratory therapist develop an accurate index of suspicion, and ultimately leads to appropriate and effective therapeutic intervention. Because obtaining a comprehensive history is time consuming, many healthcare providers assess primarily the body systems of concern. Clearly, the heart and lungs are the systems of primary interest for respiratory therapists.

**Respiratory Recap**

**Variables Supporting a Therapeutic Climate**

- Caring demeanor
- Competence
- Eye contact
- Judicious use of touch
- Professional image

**Respiratory Recap**

**The Health History**

- Chief complaint
- History of present illness
- Occupational and environmental history
- Geographic exposure
- Activities of daily living
- Smoking history
- Cough and sputum production
- Family history
- Medical history
- Review of systems

### Chief Complaint

The chief complaint (CC) is the problem or concern that prompted the patient to seek healthcare. When documenting the CC in the patient record, the examiner should use the patient's own words in quotation marks.

### History of Present Illness

The history of present illness (HPI) is the chronologic, narrative account of the patient's health problem. It should describe in detail information relevant to the CC, including a description of the onset of the problem, the date the symptoms occurred and whether they developed gradually or suddenly, and the setting in which they developed. Also included is a description of the signs and symptoms associated with the problem. The mnemonic *OLD CART* can help the examiner gather information accordingly, as follows:

***O***nset (when the problem started)
***L***ocation of pain, shortness of breath, or other symptoms
***D***uration of pain, shortness of breath, or other symptoms
***C***haracter, quantity, and quality of pain, shortness of breath, or other symptoms
***A***ssociated manifestations (the setting in which the pain, shortness of breath, or other symptoms developed)
***R***elieving factors or factors that diminish or aggravate the pain, shortness of breath, or other symptoms
***T***reatment (any medications or other remedies that relieve or exacerbate shortness of breath)

### Occupational and Environmental History

The examiner should inquire as to whether the patient is employed, retired, or laid off. Are there any current or past hazards at work, such as exposure to asbestos, coal dust, silica, molds, dust, or animals? Is the patient under stress at work? Is the patient satisfied with his or her job?

**Respiratory Recap**

**History of Present Illness**

- Onset
- Location
- Duration
- Character
- Associated manifestations
- Relieving factors
- Treatment

## Geographic Exposure

Has the patient traveled to foreign countries? Has the patient been in military service?

## Activities of Daily Living

Has the patient experienced difficulty with or change in the ability to provide self-care?

## Smoking History

Does the patient smoke cigarettes, or has the patient done so in the past? How long has the patient smoked cigarettes? This answer is usually expressed in **pack years** and is calculated as follows. A pack a day for 1 year is known as *1 pack year*. Two packs a day for a year is *2 pack years*, and so on. What is the patient's willingness to quit? The examiner should also inquire as to whether the patient smokes a pipe, cigars, or illicit drugs such as marijuana or crack cocaine.

## Cough and Sputum Production

The examiner should ask about the presence of cough and sputum. If the patient has a cough, the timing of the cough (for example, in the morning, at night, after eating) and whether sputum is produced should be noted. If sputum is produced, the examiner should determine its amount, consistency, color, and odor, as well as whether the frequency of the cough and the amount of sputum have increased recently.

## Family History

Any family history of genetically transmitted disease (for example, cystic fibrosis, alpha-1 antitrypsin deficiency), cancer, heart disease, tuberculosis (TB), or human immunodeficiency virus (HIV) should be noted.

## Medical History

Dates of past health problems, hospitalizations, symptoms, and treatment should be noted in the history, as well as whether the problem is ongoing, resolved, or recurrent. Are immunizations current? Does the patient have any food, drug, insect, or environmental allergies?

**STOP AND THINK**

You are seeing a patient for the first time. You are told that the patient has COPD. What information would you collect regarding the patient's health history?

## Review of Systems

A review of the systems provides the opportunity for the examiner to methodically question the patient about the health of each body system. It differs from the physical examination in that the data are collected verbally. A thorough review of each system is unnecessary, but the examiner should include a detailed review of the systems affected by the present illness. If the patient answers with a negative response, a denial of that specific complaint should be noted. For example, "Patient denies pain with deep inspiration and coughing."

# Vital Signs

Pulse, respirations, and blood pressure are considered *vital signs*. These are commonly measured, along with body temperature, as indicators of the patient's health status. The pulse rate and rhythm can be measured by cardiac auscultation or palpation of any artery, with the radial artery being most commonly used for this purpose. The pulse is counted for a minimum of 15 seconds and then mathematically adjusted to the rate per minute. The normal pulse rate for adults is 60 to 100 beats per minute; the rate is more rapid for infants and children. The respiratory rate is measured by inspection of the movement of the chest for 1 minute. The normal respiratory rate for adults is 12 to 20 breaths per minute; it is more rapid for infants and children.

Blood pressure is measured either with a sphygmomanometer or an indwelling arterial catheter. Normal blood pressure for adults is 120/80 mm Hg. Measurements are lower for infants and children.

Body temperature can be measured via the oral, rectal, or axillary sites using a traditional thermometer. Infrared sensors are also used for the forehead or tympanic sites. Core temperature monitoring is measured in the distal esophagus or pulmonary artery. Normal body temperature is 37° C (98.6° F). The term *fever* refers

**AGE-SPECIFIC ANGLE**

Compared with adults, infants and children have higher respiratory rates, higher pulse rates, and lower blood pressures.

**Respiratory Recap**

**Respiratory Assessment Techniques**

- Inspection
- Palpation
- Percussion
- Auscultation

to a higher-than-normal body temperature (hyperthermia), whereas hypothermia is a temperature lower than normal.

## Techniques of Assessment

### Inspection

As an examination technique, **inspection** ranges from casual observation to visual scrutiny of the patient.

### Palpation

**Palpation** is the process whereby the examiner uses the hands to feel for body movement, lumps, masses, and skin characteristics. Palpation can be either light or deep.

### Percussion

**Percussion** requires the examiner to place a finger firmly against a body part and strike that finger with a fingertip from the other hand. The technique for the right-handed examiner is as follows:

- Hyperextend the middle finger of the nondominant hand (plexímeter finger).
- Press the distal interphalangeal joint firmly on the surface to be percussed. Avoid contact with any other part of the hand because vibrations may be dampened.
- Hold the forearm of the other arm close to the surface, with the hand turned up at the wrist, and partially flex the middle finger (plexor).
- Strike the plexímeter with the tip of the plexor with a quick, sharp, and relaxed wrist motion and aim at the distal interphalangeal joint (**Figure 1-1**).

**FIGURE 1-1** Percussion technique.


Withdraw briskly to avoid dampening the vibrations. Use one to two blows at each location.

The resulting sounds can suggest either normal underlying tissue or typical sounds associated with given abnormalities.

Five percussion tones (**Table 1-1**) are commonly recognized: flat, dull, resonant, hyperresonant, and tympanic. A flat percussion note is soft, high pitched, and of short duration. It can be elicited by percussion of the thigh. A dull percussion note is of medium intensity, pitch, and duration. It is heard over the liver or a tumor. A **resonant** note is loud, low in pitch, and of long duration. It may be heard over normal lung tissue. A **hyperresonant** note is very loud, lower in pitch, longer

**Respiratory Recap**

**Percussion Notes**

- Flat
- Dull
- Resonant
- Hyperresonant
- Tympanic

**TABLE 1-1**
**Characteristics of Percussion Notes**

| Type of Tone | Intensity | Pitch | Duration | Quality |
|---|---|---|---|---|
| Flat | Soft | High | Short | Extremely dull |
| Dull | Medium | Medium-high | Medium | Thud like |
| Resonant | Loud | Low | Long | Hollow |
| Hyperresonant | Very loud | Very low | Longer | Booming |
| Tympanic | Loud | High | Medium | Drum like |

in duration, and commonly heard over an emphysematous lung. A **tympanic** note is loud and drum-like, with a high pitch. It may be heard over a gastric bubble.

### Auscultation

After inspection, **auscultation** is the most commonly used physical assessment technique, particularly for assessment of the respiratory system. Auscultation involves listening to body sounds with a stethoscope placed on bare skin. The stethoscope has several important components (**Figure 1-2**). The diaphragm is the larger side of the stethoscope head and is made of rigid plastic. The bell is the smaller cup on the other side of the head and is covered with a plastic or rubber ring. The bell is useful for detection of certain cardiac and vascular sounds. The diaphragm is used more frequently. Note that both adult and pediatric diaphragms and bells exist, with the latter being smaller. Some stethoscopes come with interchangeable parts. The examiner should ensure that the appropriate sizes are being used.

Quality stethoscopes have tubing specifically engineered to conduct sound very well. It is possible to purchase stethoscopes that actually magnify sound. Most stethoscopes, however, simply block out other noise, thereby allowing the examiner to hear body sounds unimpeded. An appropriate tubing length is about 12 inches. Earpieces must fit snugly and comfortably. The earpieces must point toward the nose of the examiner to project sound toward the tympanic membrane of the examiner's ears.


**FIGURE 1-2** Stethoscope, illustrating diaphragm and bell.


## Physical Examination of the Lungs and Thorax

The astute clinician is thoroughly familiar with human anatomy. An in-depth knowledge of structure and function is vital to the interpretation of assessment findings in terms of underlying pathologic processes. **Figure 1-3** illustrates thoracic landmarks and the surface anatomy of the chest.

### Inspection

#### Observing Respirations

The clinician must be familiar with common respiratory patterns (**Figure 1-4**). **Tachypnea** describes a persistent rate of respiration faster than 20 breaths per minute. It may be present in individuals who are hypoxemic and those who have pain in the thoracic region.

Similarly, if liver enlargement or abdominal distention compromises diaphragmatic movement, tachypnea may result. At times, however, tachypnea is merely a patient response to the realization that respirations are being observed and counted. Tachypnea also occurs in individuals with fever and in those with restrictive ventilatory defects, such as pulmonary fibrosis or pneumonectomy.

**Hyperpnea** describes breathing that is rapid, deep, and labored. If it results in a lowered $P_{CO_2}$, **hyperventilation** is the term that applies. **Kussmaul respirations** describe hyperventilation as a compensatory mechanism for metabolic acidosis, most commonly diabetic ketoacidosis. Conversely, **bradypnea** is a rate slower than 12 breaths per minute. It may suggest neurologic impairment or acid–base disturbance but may be a normal finding in physically fit individuals.

**Dyspnea** is a term that simply means difficult or labored breathing, with the individual feeling short of breath. **Platypnea** refers to an individual's difficulty in breathing unless lying flat. **Orthopnea** indicates that an individual must sit or stand to breathe. Many individuals with chronic lung disease must assume an upright position to breathe well. Such individuals

**Respiratory Recap**

**Patterns of Respiration**

- Tachypnea
- Hyperpnea
- Kussmaul respirations
- Bradypnea
- Dyspnea
- Platypnea
- Orthopnea
- Paroxysmal nocturnal dyspnea
- Cheyne-Stokes respirations
- Biot respirations

often find it more comfortable to sleep in a chair. **Paroxysmal nocturnal dyspnea** is characterized by sudden shortness of breath that occurs several hours after the individual lies down. It commonly suggests cardiac dysfunction in that the heart is unable to adequately pump a circulatory volume expanded by fluid reabsorbed from the legs, which became edematous during the day.

**Cheyne-Stokes breathing** is characterized by episodes of slow, shallow breaths, which rapidly increase in depth and rate. This crescendo-decrescendo pattern is followed by periods of apnea. Such breathing may be a normal variant in young children and the elderly. Otherwise, it occurs in individuals with cerebral vascular disease and congestive heart failure.

**Biot respirations** are symptomatic of elevated intracranial pressure and meningitis. This breathing pattern is characterized by a short burst of uniform, deep respirations, followed by periods of apnea lasting 10 to 30 seconds.

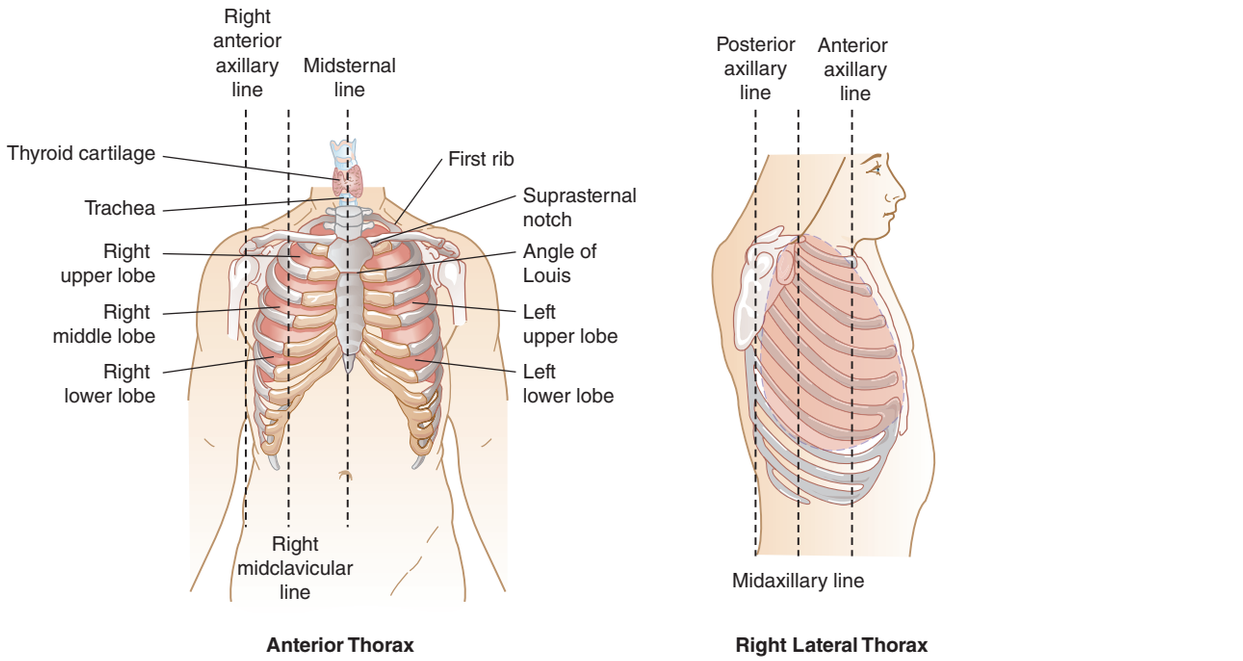



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**FIGURE 1-3** (**A**) Thoracic landmarks. (**B**) Topographic landmarks of the chest.

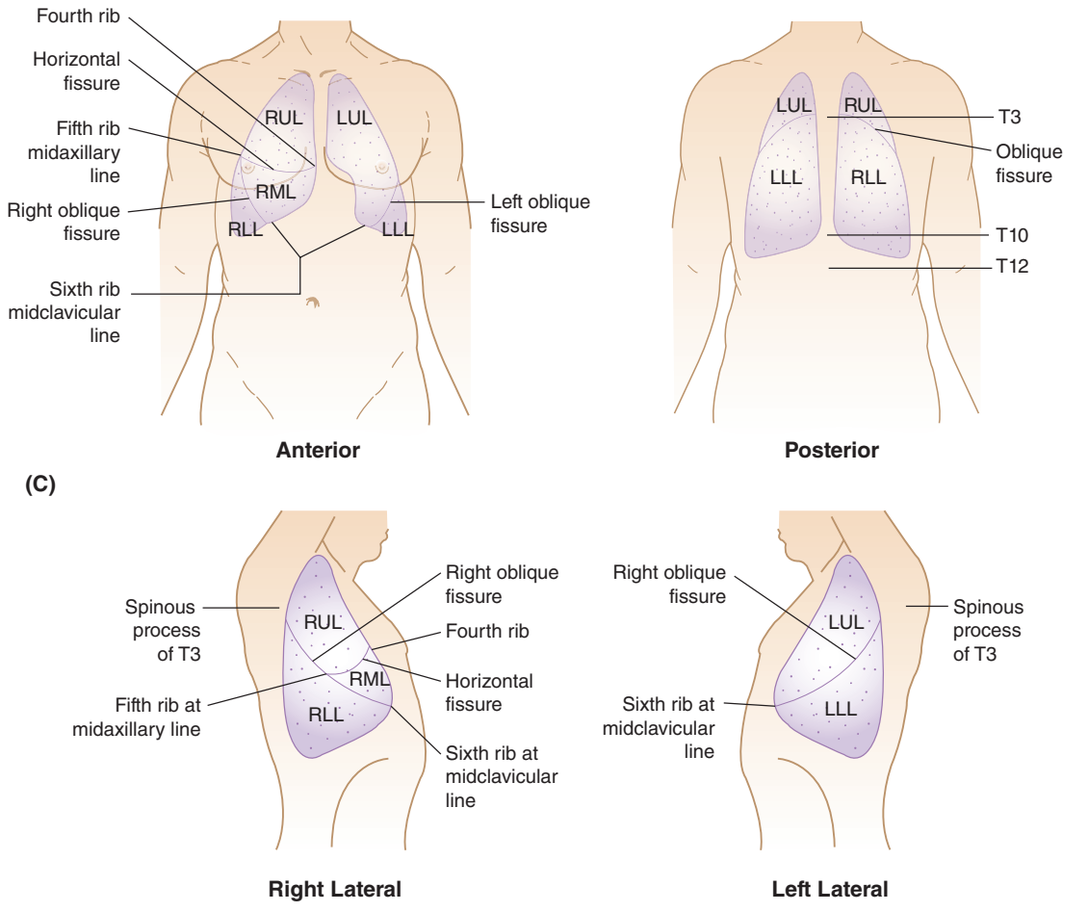


**FIGURE 1-3** (*Continued*) (**C**) Surface anatomy of the thorax.

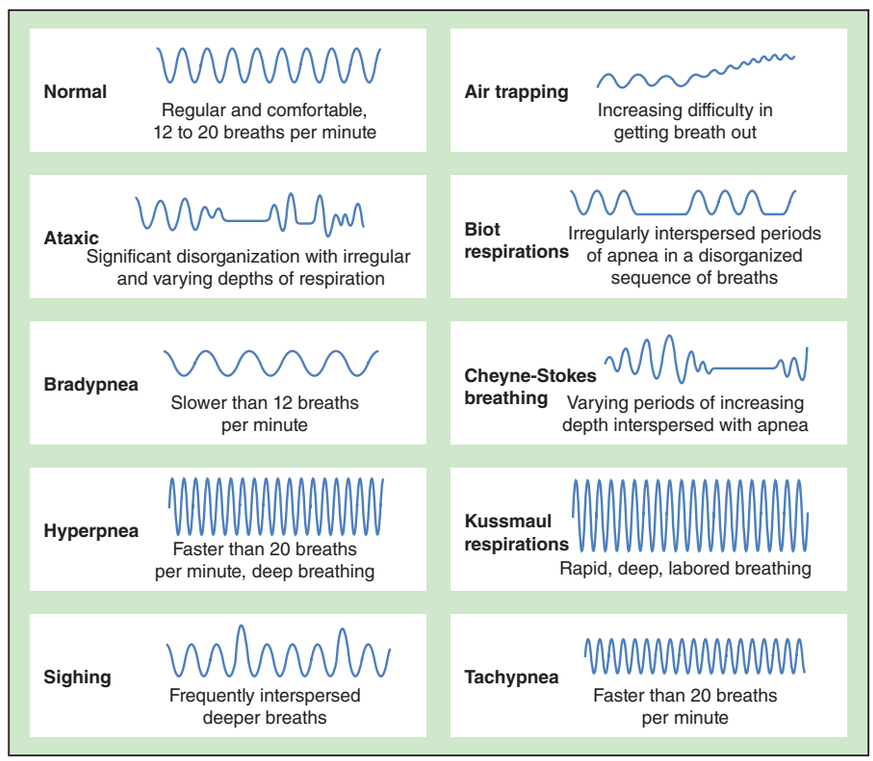


**FIGURE 1-4** Patterns of respiration.

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## Use of Accessory Muscles

Muscles of the back, neck, and abdomen are known as *accessory muscles* of respiration. Although they play a relatively minor role in normal respiration, their function becomes more prominent during exercise or respiratory distress. Use of accessory muscles implies an increased work of breathing or diaphragm weakness.

Retractions suggest a barrier to inspiration, occurring anywhere along the respiratory tract. To overcome this barrier, the respiratory muscles contract more vigorously, resulting in a more negative intrapleural pressure. Retractions resemble a "sucking in" of structures, such as the intercostal spaces, suprasternal space, and subclavian spaces. In such a situation, the examiner documents that the patient "has retractions," "is retracting," or "is using accessory muscles."

## Nasal Flaring and Pursed-Lip Breathing

Individuals in respiratory distress commonly exhibit nasal flaring, presumably in an attempt to decrease the resistance to airflow through the nostrils. Those with emphysema commonly use pursed lips during the expiratory phase to maintain airway patency and better control expiratory flow.

## Flail Chest and Paradoxical Respiration

**Flail chest** is a term describing the appearance of a thorax with multiple rib fractures, causing instability of the chest wall. In this situation the chest wall moves outward on expiration and inward on inspiration. This movement, which is contrary to normal chest movement, is known as **paradoxical respiration**. Flail chest with paradoxical respiration indicates a serious injury and will result in hypoxia if left untreated.

The chest and abdomen also should move in synchrony during the respiratory cycle. Paradoxical inward movement of the abdomen during the inspiratory phase indicates diaphragm weakness or paralysis. Paradoxical inward movement of the chest wall during inspiration indicates paralysis of the chest wall muscles, as may occur with high thoracic spine injury or low cervical spine injury.

## Shape of the Chest

The examiner should observe the shape of the patient's chest. Abnormalities of the thorax can be significant factors in lung disease. Typically, a patient with emphysema has a **barrel chest** (**Figure 1-5**). The lateral diameter of the chest is normally twice the anteroposterior diameter. With a barrel-shaped chest configuration, the anteroposterior diameter is equal to the lateral diameter. Although obstructive lung disease causes this characteristic change in chest configuration, certain other abnormalities of thoracic shape result in restrictive lung disease. **Pectus excavatum**, or a funnel-shaped sternum, describes a sternum that is depressed and deviated somewhat like a funnel (**Figure 1-6**). Similarly,

**FIGURE 1-5** Barrel chest.

**FIGURE 1-6** Pectus excavatum.
Top © Custom Medical Stock Photo; bottom © M. English, MD/Custom Medical Stock Photo.

**pectus carinatum**, or a pigeon-breasted sternum, describes a chest that bows out at the sternum, similar to that of a pigeon. These abnormalities in thoracic configuration may result in lung disease as the patient ages. **Scoliosis**, for instance, causes lateral curvature of the spine, **kyphosis** causes forward curvature of the spine, and **lordosis** causes backward curvature of the spine (**Figure 1-7**).

The examiner also should note whether the trachea is midline in the neck. A tension pneumothorax causes tracheal deviation away from the collapsed lung. Atelectasis or lung resection causes the trachea to be deviated toward the affected side.

### Skin Color

The color of the patient's skin should be noted. Although several abnormalities in skin color exist, **cyanosis** is of prime significance to the respiratory therapist. When hemoglobin is poorly saturated with oxygen, the skin assumes a bluish hue, which is initially apparent in the nail beds. Cyanosis may be present normally in the nail beds of a person who is vasoconstricted as a result of exposure to cold temperatures. Cyanosis also may be noted in the mucous membranes of the mouth; this site is of particular use in the assessment of individuals with dark skin. Cyanosis also can appear around the mouth (circumoral). In healthy children, circumoral cyanosis is quite common, particularly when they are cold. The significance of cyanosis must be evaluated in light of other clinical findings.

**Pallor** is the term assigned to describe diminished skin color accompanying anemia. It also may be seen in individuals with severe peripheral vasoconstriction accompanying shock. Detecting pallor is easier in lighter-skinned individuals, but the color of darker skin also appears paler when the individual is severely anemic.

**Plethora** is a term describing the fullness of blood vessels at the skin surface. Plethora may occur with vasodilation and may be present in individuals who are hypercapnic. **Jaundice** is the yellowish skin color arising from an elevated serum bilirubin level. Any disorder resulting in bile being retained in the liver ultimately causes jaundice. Jaundice is first apparent in the sclera of the eyes.

**Respiratory Recap**

**Skin Color**

- Cyanosis
- Pallor
- Plethora
- Jaundice

**STOP AND THINK**

Before initiating a respiratory care plan, you are assessing a patient with a history of COPD. The patient is thought to have pneumonia precipitating an exacerbation. What are your considerations when performing a physical assessment?

### Clubbing of Fingers

Clubbed fingers result from enlargement of the distal phalanges and develop as a compensatory mechanism when an individual has chronic hypoxia, such as with congenital heart defects or chronic lung disease. The appearance of **clubbing** is exactly as the term implies: the finger distal to the base of the nail looks like a small club (**Figure 1-8**). Affected fingertips appear full, fleshy, and vascular. Clubbing is associated with lung tumors, bronchiectasis, cystic fibrosis, congenital heart disease, and liver and gastrointestinal disease. It is hereditary in some cases. However, clubbing does *not* occur with chronic obstructive pulmonary disease.

## Palpation

### Subcutaneous Emphysema

Subcutaneous emphysema is the presence of air in the subcutaneous tissues of the neck, chest, and face. The tissues may be painful and appear swollen. In addition, a crackling or popping sound may be auscultated when a stethoscope is placed over the tissue. An examiner also may detect subcutaneous emphysema by palpating bubbles as the finger pads are rolled over the affected areas.

### Respiratory Expansion

The assessment of respiratory expansion is used primarily to determine whether the lungs are expanding symmetrically. Asymmetry of expansion may be present with a pneumothorax, atelectasis, lung resection, or main stem intubation. To perform this examination, the examiner places the thumbs along each costal margin at the back.

The hands then are slid medially to raise loose skin folds between the thumbs. The patient is asked to inhale deeply, and the examiner notes the range and symmetry of respiratory expansion by observing how the skin fold spreads out.

### Tactile Fremitus

**Tactile fremitus** is defined as the palpation of vibrations of the chest wall as a patient speaks. To elicit these vibrations, the examiner presses the bony part of the palm of the hand against the patient's chest wall. For comparison between lungs, both sides are assessed concurrently.

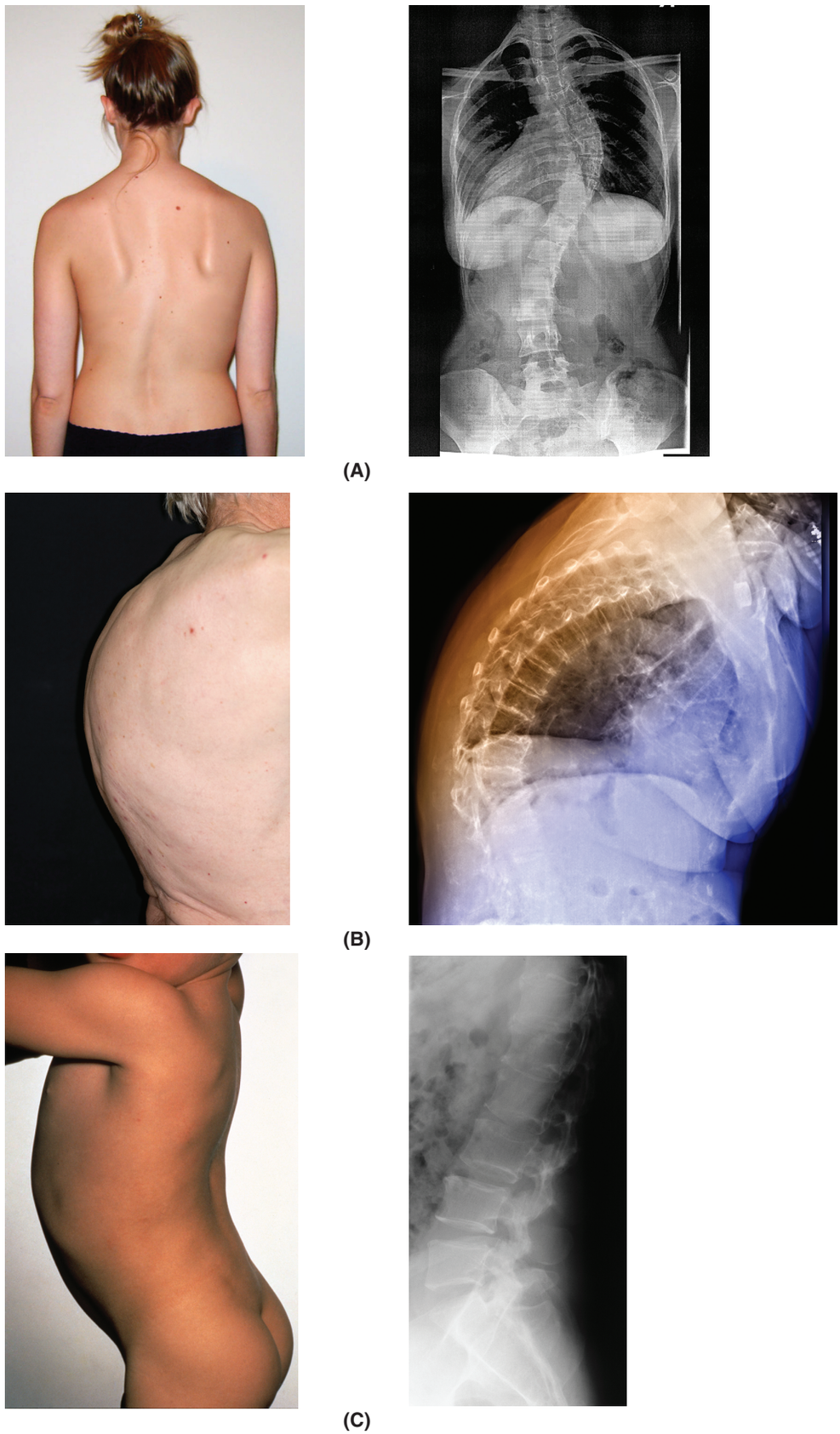

**FIGURE 1-7** (**A**) Scoliosis. (**B**) Kyphosis. (**C**) Lordosis.

(**A**) left and right, courtesy of Darci Manley; (**B**) left © Dr. P. Marazzi/SPL/Science Source, right © Apogee/Science Source; (**C**) left © Wellcome Trust Library/Custom Medical Stock Photo, right © medicalpicture/Alamy Images.

(A)

(B)

**FIGURE 1-8** (**A**) Clubbing of the finger. (**B**) Normal digit.
(**A**) © Biophoto Associates/Science Source; (**B**) © Jorge Salcedo/ShutterStock, Inc.

The patient is asked to repeat the words *ninety-nine* or *one-one-one*. When the lungs are healthy, vibrations are barely palpable. When the lung tissue is consolidated, however, vibrations are increased. Consolidation occurs when lung tissue that is normally aerated is "made solid" by filling with fluid, mucus, pus, or cellular debris. In the patient with large amounts of secretions in the airways, palpation of the fremitus that is produced may be possible as gas flows past the secretions.

## Percussion

Chest percussion can be used to elicit several abnormal findings. With a pneumothorax or emphysema, the affected hemithorax produces a hyperresonant or tympanic percussion note. With consolidation, pleural effusion, or atelectasis, the percussion note is dull or flat. A useful application of percussion is to determine diaphragmatic excursion. The difference in posterior, dependent resonance between maximum inhalation and maximum exhalation represents diaphragmatic excursion (**Figure 1-9**). Diaphragmatic excursion is affected by emphysema, pneumothorax, pleural effusion, atelectasis, consolidation, phrenic nerve injury, and diaphragmatic weakness.

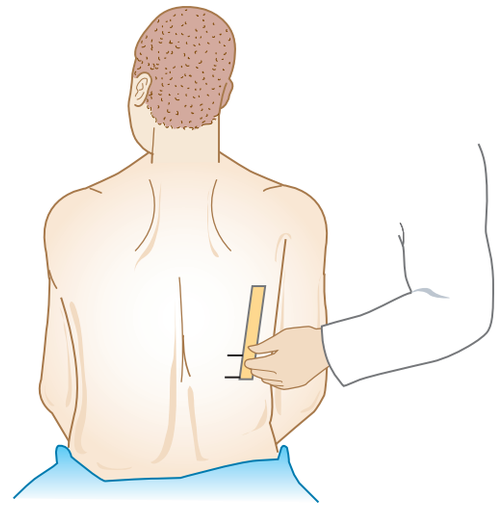

**FIGURE 1-9** Measuring diaphragmatic excursion.

## Auscultation

The stethoscope is the most frequently used instrument in respiratory assessment and yields valuable information about the status of the lungs. Because the lower lobes of the lungs are posterior in the thorax, complete auscultation of breath sounds through the anterior chest wall is impossible. Therefore, examiners should avoid the temptation to auscultate only the anterior chest wall because of its easy accessibility. Auscultation of the posterior chest wall generally yields more useful information.

The sequence for lung field auscultation is shown in **Figure 1-10**. The examiner first should assess the apices of the lungs as they extend above the scapulae by listening on one side of the thorax and then moving to the corresponding area on the other side. Below the scapulae the examiner continues to move back and forth, listening to corresponding areas on both sides and comparing the sounds. Sounds generated by normal lungs differ according to location in the respiratory system (**Table 1-2**).

### Intensity of Breath Sounds

Breath sounds may be reduced in individuals with a number of conditions. They can be diffusely decreased with shallow breathing or with the hyperinflation and decreased airflow that occur with hyperinflation (for example, emphysema or acute asthma). Localized diminished breath sounds occur with airway obstruction, atelectasis, and main stem intubation. Decreased breath sounds at the lung bases are commonly associated with postoperative atelectasis.

### Characteristics of Normal Breath Sounds

**Bronchial breath sounds** are heard over the trachea, at the manubrium anteriorly, and between the scapulae posteriorly. These breath sounds are louder

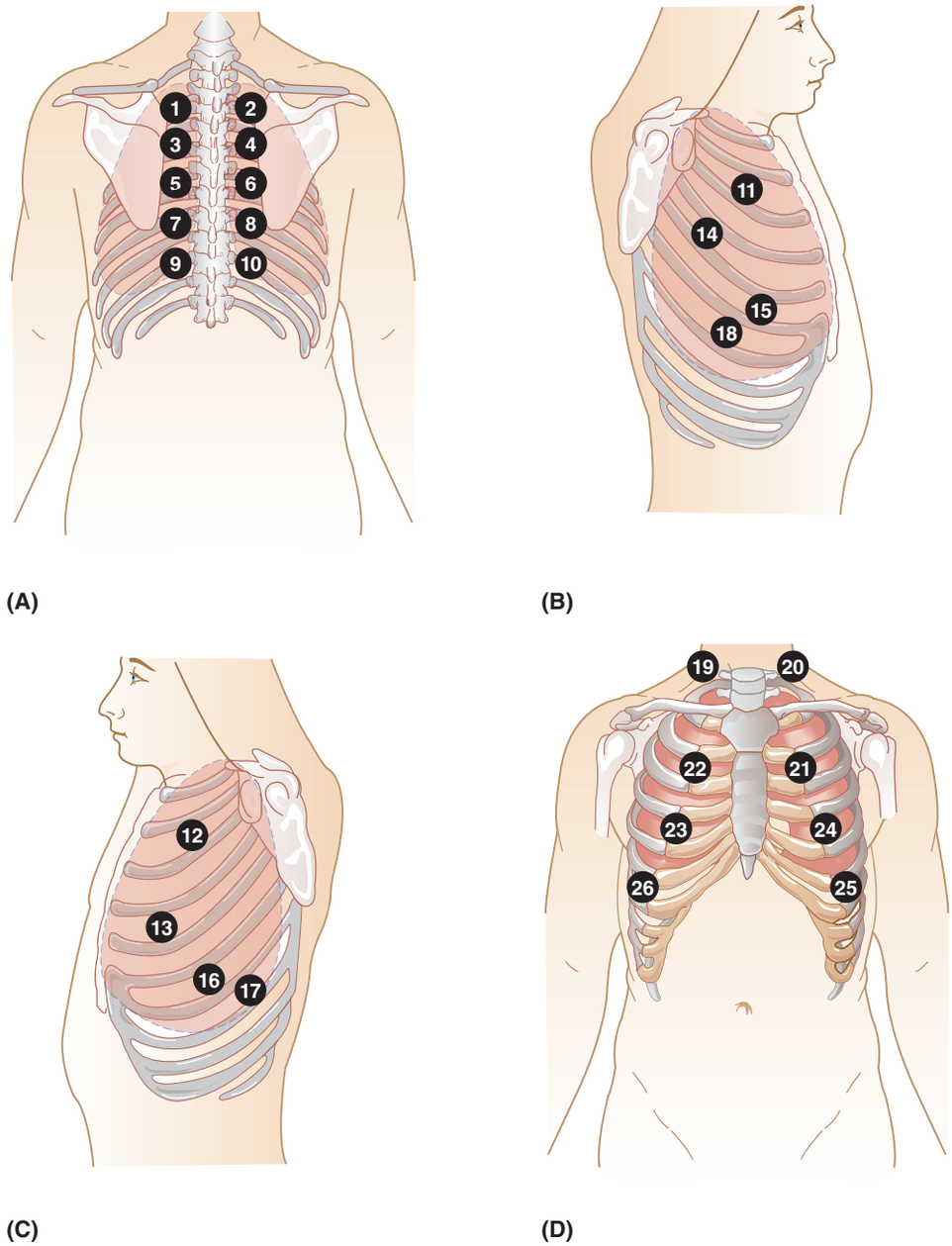


**FIGURE 1-10** Suggested sequence for systematic percussion and auscultation of the thorax from the posterior (**A**), right lateral (**B**), left lateral (**C**), and anterior (**D**) views.

**TABLE 1-2**
**Lung Sounds Assessed by Auscultation**

| Sound | Characteristics |
|---|---|
| Vesicular | Heard over most lung fields; low pitch; soft and short expirations; accentuated in thin person or child and diminished in overweight or very muscular individuals |
| Bronchovesicular | Heard over main bronchus area and upper right posterior lung field; medium pitch; expiration equaling inspiration |
| Bronchial/tracheal (tubular) | Heard only over trachea; high pitch; loud and long expirations, often somewhat longer than inspiration |

and higher in pitch. Expiratory sounds are as long as or slightly longer than the inspiratory component. **Bronchovesicular** breath sounds are heard over the junction between the bronchi and alveoli. Anteriorly, the sounds occur in the first and second interspaces between the ribs. Inspiratory and expiratory phases are equally long. **Vesicular breath sounds** are heard over the lung periphery. These sounds are soft and low pitched, and inspiration lasts longer than expiration.

## Characteristics of Abnormal Breath Sounds

Bronchial breath sounds heard over the periphery or in the bases of the lungs suggest consolidation of lung tissue. Consolidation occurs when lung tissue that is normally aerated is made solid by filling with fluid, mucus, pus, or cellular debris. Consequently, sounds generated by air movement through the bronchi resonate more clearly to pulmonary regions where only vesicular or bronchovesicular sounds are normally heard.

Other sounds typical of consolidation are the so-called voice sounds—bronchophony, egophony, and whispered pectoriloquy. **Bronchophony** is elicited when the examiner auscultates over an area of suspected consolidation and asks the patient to say the words *ninety-nine*. Normally, this sound is muffled, but when heard over consolidated lungs, the words are clearly audible. Similarly, **egophony** is elicited when the patient is asked to say the letter *e*. Over normal lung fields, the verbalization of the letter *e* sounds like *e*. When consolidated areas of the lung are auscultated, however, the annunciation of the letter *e* converts to the sound made by annunciation of the letter *a*. This is termed the "e to a" phenomenon. The third voice sound, **whispered pectoriloquy**, can be evoked when the patient is asked to whisper the numbers *1*, *2*, and *3*. Normally this sound is soft, but with lung consolidation, it is clearly audible.

**Respiratory Recap**

**Auscultation**

- Intensity of breath sounds
- Presence of bronchial breath sounds
- Presence of adventitious breath sounds: crackles, rhonchi, wheezes, stridor, pleural friction rubs

## Crackles

**Crackles**, or rales (pronounced *rawls*, although many clinicians say *rails*), are commonly heard adventitious, or abnormal, breath sounds (**Figure 1-11**). Crackles are classified as discontinuous sounds, meaning that they wax and wane during each respiratory cycle. They are usually heard at the end of inspiration and are fine in quality and high pitched. Crackles result when the terminal airways pop open late in inspiration because fluid or secretions have accumulated. Consequently, crackles are heard most often over the lung bases.

Crackles are a common finding in individuals with congestive heart failure. In this condition, fluid accumulates first in the interstitial spaces between the capillaries and alveoli. As the condition worsens, the fluid fills the alveoli. Initially the crackles are heard in the bases of the lungs. Crackles that ascend higher up the lung fields are related to an increasing degree of congestive heart failure. In cases of pneumonia, crackles are heard over the involved lobe. In some normal individuals who have remained supine for long periods, crackles may be auscultated in the dependent areas of the lung.

## Rhonchi

The definition of a **rhonchus** (singular) or *rhonchi* (plural) is subject to some debate. To a certain degree the use of the term varies among clinical practice sites.

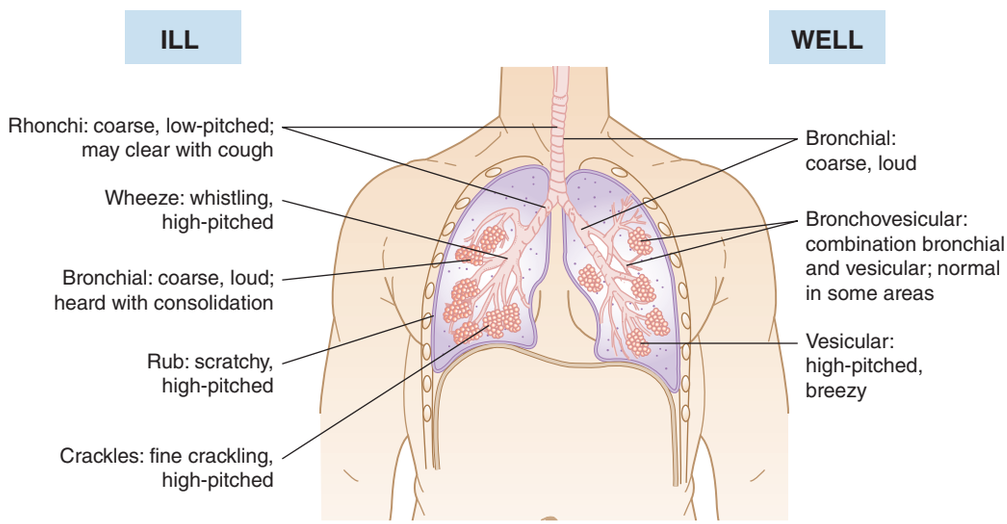


**FIGURE 1-11** Breath sounds noted in the ill and well patient.

**STOP AND THINK**

How might the findings during auscultation be different for a patient with COPD, a patient with congestive heart failure, and a patient with both COPD and congestive heart failure?

However, the American Thoracic Society has defined *rhonchi* as being deeper, rumbling sounds that are more pronounced on expiration. These sounds are likely to be continuous. Generally, they are caused by air passing through an airway partially obstructed by thick secretions, spasm of the airways, or presence of a tumor. Higher-pitched or sibilant rhonchi arise in the smaller bronchi, such as in the case of asthma. Lower-pitched, sonorous, or snoring rhonchi are more commonly heard in association with thick secretions in the larger airways. At times the rumbling may be palpable through the chest wall.

### Wheezes

**Wheezes** may be either high or low in pitch. High-pitched wheezes are often called *sibilant* wheezes. They are musical or whistling in nature, caused by air passing through narrowed airways, such as in the bronchospasm of asthma (reactive airway disease). Most often, sibilant wheezes are heard on expiration, although they may be heard throughout the respiratory cycle. Although wheezes are most often associated with asthma, wheezes also can be present in individuals with other conditions, such as congestive heart failure and foreign body aspiration.

### Stridor and Grunting

**Stridor** is a crowing sound commonly caused by inflammation and edema of the larynx and trachea. It may be heard after extubation, when tracheal damage has occurred with resultant edema. Stridor, however, is most commonly associated with croup in children and frequently is accompanied by a barking cough. Usually, stridor is a nocturnal assessment finding probably related to the development of edema in the upper airway while a child is in a dependent position during sleep. Mouth breathing related to nasal congestion often causes a drying and, thus, thickening of secretions that further compounds the stridor. The constellation of findings includes improvement of symptoms with air humidification. Taking the child outside into the cool night air may be an effective intervention. If the child does not improve, however, the stridor must be evaluated further because of the danger of airway obstruction. **Grunting** is a sound heard in newborns with respiratory distress. It occurs when the glottis is closed in an attempt to maintain lung volume.

**AGE-SPECIFIC ANGLE**

- Stridor is associated with croup in children. Grunting is associated with respiratory distress in the newborn.

### Pleural Friction Rubs

A **pleural friction rub** is a continuous grating sound such as is audible when two pieces of leather are rubbed together. Another analogy is that friction rubs sound as though the palms of both hands are sliding against each other. This sound is produced when the visceral and parietal pleurae become inflamed and no longer glide silently against each other during the respiratory cycle. Consequently, the sound is localized and exists only over the area of pleural irritation. Pleural friction rubs may be intermittent.

Pleural friction rubs may accompany a pleural effusion—the accumulation of fluid in the usually empty pleural cavity. Causes of pleural effusion include malignant seeding of metastatic tumors onto the pleural linings. Pleural friction rubs also may be heard in individuals with infectious processes involving the pleural cavity. After thoracic surgery, residual blood in the pleural cavity eventually becomes sludge and may irritate the pleurae, resulting in a friction rub.

### Signs of Respiratory Distress

**Table 1-3** lists the common physical findings of respiratory diseases.

## Assessment of Other Body Systems

The respiratory system interfaces with all other organ systems. Consequently, evaluation of the respiratory system does not occur in an assessment vacuum. The following discussion highlights assessment techniques used to monitor the heart, blood vessels, and brain.

### The Heart and Blood Vessels

#### Location and Significance of Various Chest Landmarks

The chest wall overlying the heart is known as the **precordium**. Each heart valve is auscultated best by placement of the stethoscope in a specific location on the precordium. To do so, the cartilaginous structures—*interspaces*—lying between the ribs must be located, first by identification of the clavicle. Note that the space immediately under the clavicle does not count as an interspace. Next, the first rib should be identified. The cartilage under the first rib is the first interspace. Count the ribs by movement of the fingers down from each rib to the corresponding interspace.

**TABLE 1-3**
**Physical Findings of Respiratory Diseases**

| Condition | Percussion Note | Fremitus | Breath Sounds | Adventitious Sounds |
|---|---|---|---|---|
| Normal | Resonant | Normal | Vesicular | None |
| Left heart failure | Resonant | Normal | Vesicular | Crackles or occasionally wheezes |
| Pleural effusion | Dull or flat | Decreased | Decreased or absent | None or pleural rub |
| Consolidation | Dull | Increased | Bronchial | Crackles, rhonchi, or egophony |
| Bronchitis | Resonant | Normal or decreased | Prolonged exhalation | Wheezes, crackles, or rhonchi |
| Emphysema | Hyperresonant | Decreased | Decreased or absent | None |
| Pneumothorax | Hyperresonant | Decreased | Decreased or absent | None |
| Atelectasis | Dull | Decreased | Decreased or bronchial | None or crackles |
| Asthma | Resonant or hyperresonant | Normal or decreased | Vesicular | Wheezes |
| Pulmonary fibrosis | Resonant | Normal | Vesicular | Crackles |

The accuracy of the counting process may be verified in the following way. Identify the ridge of bone that is the joint between the manubrium and sternum, known as the *sternal angle* or *angle of Louis*. The interspace to either side immediately below the sternal angle is the second interspace. On the posterior thorax the spinous processes of the vertebrae are useful landmarks. The spinous process of the seventh cervical vertebra (C7) is identified when the patient extends the head and neck forward and down. The most prominent spinous process is C7; directly below that is the first thoracic vertebra (T1). A thorough cardiac auscultation involves systematic movement of the stethoscope over the precordium. A first step taken by the novice examiner is to switch the focus of attention from simply counting each cardiac contraction to a focus on the quality of the sounds created by the valves and any variations in the sounds associated with $S_1$ and $S_2$. The examiner should keep the stethoscope in each location for several cardiac cycles.

Bearing in mind that $S_1$ and $S_2$ are heard anywhere in the precordium, the examiner begins a thorough examination by focusing on the sounds created by the semilunar valves—the aortic and pulmonic valves. These valves are located at the base of the heart, which is actually the top of the heart where the great vessels exit. Variations associated with alterations of aortic valve function are best assessed in the second interspace to the right of the sternal border, where they are heard best because the valve points in that direction (**Figure 1-12**). The stethoscope then is moved to the second interspace at the left sternal border, the best location for assessment of pulmonic valve function.

All other assessments occur on the left side of the sternum. Tricuspid valve variations are heard best at the fifth interspace at the left sternal border, and the mitral valve is assessed where the fifth interspace intersects the midclavicular line. The mitral valve, or apical area, is not only useful as a landmark for

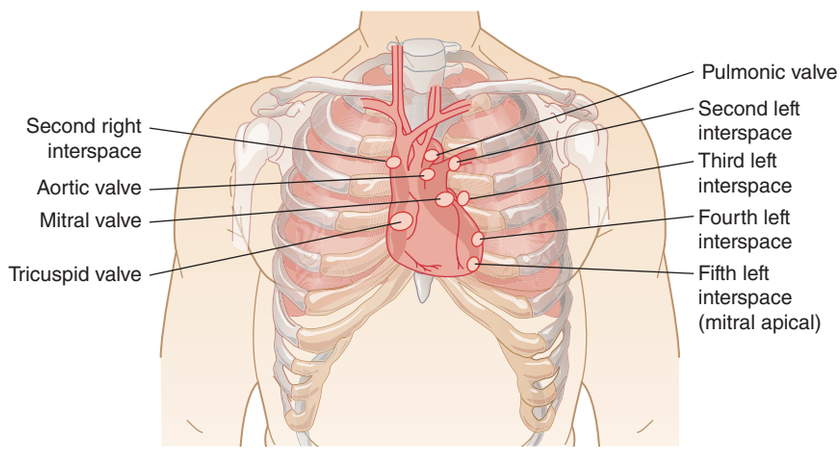


**FIGURE 1-12** Areas for auscultation of the heart.

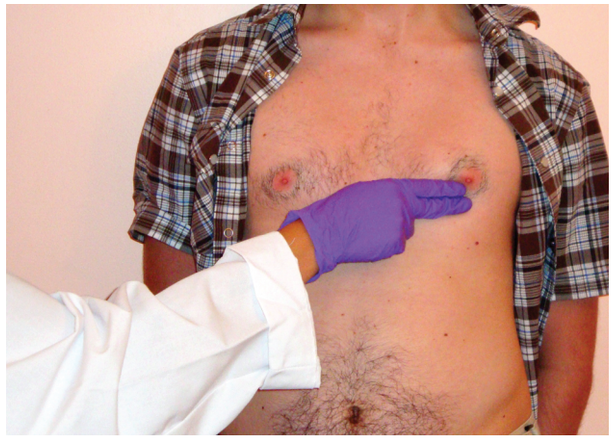

**FIGURE 1-13** Palpation of the apical pulse.

auscultation but also provides other useful information. This relatively small left ventricular apex is the area where the left ventricle protrudes from behind the right ventricle, known as the *point of maximal impulse (PMI)*. The left ventricle taps gently against an area of the thoracic wall no more than 2 cm in diameter (**Figure 1-13**). Left ventricular hypertrophy may be the cause of an enlarged PMI.

## Cardiac Auscultation

Listening to heart sounds involves notations of rate and rhythm, extra heart sounds, and murmurs. Heart rate and rhythm should be observed first. A regular rhythm with a rate between 60 and 100 beats per minute is ideal; however, certain irregularities represent harmless variants. Conversely, other irregularities may herald serious consequences. Auscultation used to determine rate and rhythm is done with the stethoscope at the apex of the heart, a procedure commonly known as *taking an apical rate*.

### $S_1$ and $S_2$

Normal heart sounds are classified as $S_1$ and $S_2$ (*S* originates simply from the word *sound*). $S_1$ is the first heart sound and results from closure of the atrioventricular (mitral and tricuspid) valves. $S_1$ is also described as sounding like *lub*. As the ventricles eject most of their blood, ventricular pressure drops below aortic pressure, resulting in closure of the aortic and pulmonic valves, which in turn produces $S_2$, or the second heart sound, also known as *dub*.

A normal variant may be auscultated with the stethoscope at the second interspace along the left sternal border. In many individuals, a split $S_2$ may be heard here during inspiration, a sound that occurs when pulmonic valve closure happens a few milliseconds after closure of the aortic valve. Typically, this action takes place during inspiration, as increasing intrathoracic pressure causes blood to strike the pulmonic valve with greater force.

### $S_3$ and $S_4$

$S_3$ and $S_4$ are extra sounds generated by certain aberrant blood flow mechanisms. These sounds are best heard at the left fifth intercostal space at the midclavicular line, also known as the *mitral*, or *apical*, *area*. An $S_4$ immediately precedes the $S_1$, and the $S_3$ follows immediately after the $S_2$. These rhythms are commonly called *gallops* because of their resemblance to the sound of a horse galloping. To auscultate for either an $S_3$ or an $S_4$, the bell of a stethoscope is pressed lightly against the skin. Pressing too firmly obliterates the sounds. The $S_3$ and $S_4$ are heard best with the patient in a left side-lying position.

An $S_3$ results from rapid ventricular filling. When ventricular pump failure occurs, an increased amount of residual blood remains in the heart chambers after a contraction. Consequently, the ventricles fill faster during diastole. This pumping of blood into an already partially filled ventricle causes vibrations heard as an $S_3$. An $S_3$ occurs immediately after the $S_2$. It resembles a split $S_2$ but differs in location and timing. A split $S_2$ is heard in the pulmonic area and varies with respiratory cycle, whereas the $S_3$ is heard at the apex.

An $S_4$ is a sound caused most often by a stiff ventricle, such as may be the case in hypertension or after a myocardial infarction. For an $S_4$ to be present, an atrial contraction must occur. Consequently, this heart sound is often known as an *atrial gallop*. An $S_4$ cannot exist in the presence of atrial fibrillation, a condition in which the atria do not contract. The vibrations causing an $S_4$ are thought to be due to atrial contraction occurring in the presence of a stiffened or *noncompliant* ventricle. The $S_4$ precedes the $S_1$.

## Murmurs

A simple description of a cardiac **murmur** is an extra sound heard in conjunction with $S_1$ and $S_2$. Several mechanisms describe the etiology of murmurs. Murmurs occur when blood regurgitates into the chamber from which it came. Sometimes valvular dysfunction develops as a sequela to rheumatic heart disease after infection with β-hemolytic streptococci. This syndrome results in valves that are distorted in shape and calcified.

Other murmurs arise when a large volume of blood flows through a valve, such as occurs during pregnancy, anemia, or hyperthyroidism. Murmurs also result from blood flowing through a narrowed or stenotic valve. A final category of murmurs arises from congenital defects resulting in blood flow through openings not normally present.

### Classification of Murmurs

Murmurs are classified as early, middle, or late systolic—that is, occurring between $S_1$ and $S_2$. Others are diastolic, coming between $S_2$ and the next $S_1$. The intensity of murmurs is graded from I to VI and is recorded in Roman numerals. A grade I murmur

**Respiratory Recap**

**Cardiac Auscultation**

- Heart rate and rhythm
- Extra sounds
- Murmurs

is very faint and may not be heard in all positions. Generally, a highly trained ear is required for detection of this sound. Murmurs that are grades II through IV increase progressively in intensity, with a grade V murmur being very loud. A grade VI murmur may be heard without the stethoscope in contact with the chest.

Murmurs differ in quality and are described as blowing, rasping, harsh, coarse, grating, whistling, or musical. In addition, they are classified according to the location at which the sound is loudest. This location corresponds to the area of the precordium where the valve in question is best auscultated, such as the fifth interspace midclavicular line or mitral area.

### Murmurs and Infective Endocarditis

Many murmurs are classified as functional, innocent, or physiologic, meaning that they are clinically insignificant. Others are significant in that they suggest a progressive pathologic process that may eventually require surgical intervention. Some murmurs signify a defect that requires prophylaxis against *infective endocarditis*. Formerly known as *subacute bacterial endocarditis*, infective endocarditis develops when bacteria colonize on the heart valves. The immune response causes growth of fibrotic tissue, which consequently results in development of vegetation on valves. Clearly, this interferes with efficient hemodynamics, and a murmur ensues. Another danger exists if the vegetation breaks off and the resulting emboli lodge elsewhere in the body. The bacteria then reproduce in that location. *Prophylaxis against infective endocarditis* is the term given to antibiotic therapy administered before any invasive or surgical procedure, including dental work. Innocent or physiologic murmurs require no such prophylaxis; however, innocence can be determined only by echocardiogram. Diastolic murmurs suggest the need for prophylaxis against infective endocarditis.

## Jugular Venous Distention

The inspection component of a cardiac assessment primarily involves observation of the right internal jugular vein, the vessel that reflects pressure changes better than other superficial veins. Oscillations in this vein reflect changing pressures within the right atrium. Similarly, distention of this neck vein suggests a distended right ventricle, which often suggests right ventricular failure. Distended neck veins are normal

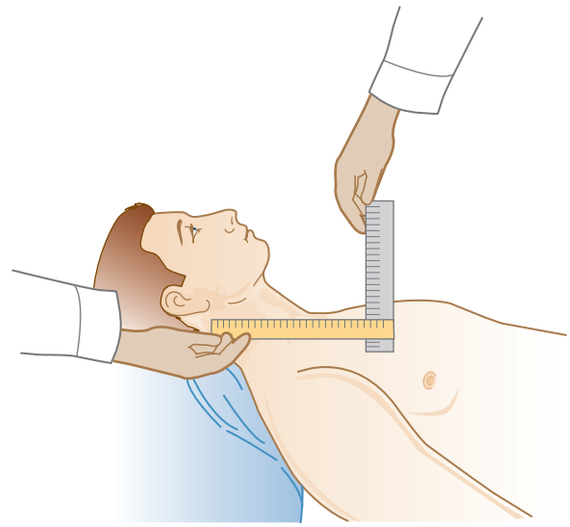

**FIGURE 1-14** Technique used to measure jugular venous distention.

in an individual in the supine position. Furthermore, neck veins fill temporarily with any activity that raises intrathoracic pressure, such as coughing, conversing, or bearing down (the Valsalva maneuver).

To assess for pathologic processes, however, the following technique is used to determine the degree of jugular venous distention. The patient is placed in a supine position, with the head of the bed at a 45-degree angle (**Figure 1-14**). With a centimeter ruler, the vertical distance between the sternal angle and the highest level of jugular vein pulsation then is measured on both sides. Neck veins that fill to a level of 2 cm or less are considered normal. Higher than this level suggests increased right ventricular pressure and is associated with right-sided heart failure.

# The Neurologic System

Because of the system's complexity, an assessment of the neurologic system can be daunting. This brief summary focuses on the most common neurologic abnormalities.

## Level of Consciousness

When a patient experiences an alteration in the level of consciousness because of trauma or some other hypoxic or metabolic event, the Glasgow Coma Scale (**Table 1-4**) is commonly used. This scale uses a numeric scoring method to document eye-opening response, verbal response, and integrated motor response. Scores range from a low of 3 points, which suggests brain death, to a maximum of 15 points, which indicates full consciousness.

Other indications of neurologic integrity are normality and equality of strength in all extremities. Clearly, any less-than-normal finding suggests impairment and warrants full evaluation. Pupils may be evaluated for size, equality, reaction to light, and

**TABLE 1-4**
**Glasgow Coma Scale**

| Observation | Score |
|---|---|
| **Eye Opening** | |
| Spontaneous | 4 |
| In response to voice | 3 |
| In response to pain | 2 |
| None | 1 |
| **Verbal Response** | |
| Oriented response | 5 |
| Confused response | 4 |
| Inappropriate words | 3 |
| Incomprehensible words | 2 |
| None | 1 |
| **Motor Response** | |
| Obeys commands | 6 |
| Localizes | 5 |
| Withdraws | 4 |
| Flexes (decorticate) | 3 |
| Extends (decerebrate) | 2 |
| None | 1 |

accommodation. Normal reactivity is documented as *PEARLA*, or *pupils equal and reacting to light and accommodation*. Although pupillary assessment is commonly performed, however, abnormalities in size and reaction are a late finding and may indicate significant brain dysfunction.

A decreasing level of consciousness is the first finding to suggest neurologic impairment. Because sleep is itself a decreased level of consciousness, however, it is important to distinguish between normal sleep and a state suggesting a serious pathologic condition—such as is the case in carbon dioxide narcosis or respiratory failure. In critically ill, mechanically ventilated patients, sedation and decreased level of consciousness are often pharmacologically induced. The level

**STOP AND THINK**

You are assessing a mechanically ventilated patient in the ICU. What considerations are important in the neurologic assessment of the patient?

**TABLE 1-5**
**Ramsay Sedation Scale**

| Level | Response |
|---|---|
| 1 | Anxious, agitated, restless |
| 2 | Cooperative, oriented, tranquil |
| 3 | Responding to commands only |
| 4 | Asleep, brisk response to stimulus |
| 5 | Asleep, sluggish response to stimulus |
| 6 | Unarousable |

of sedation in these patients is often assessed with the Ramsay score (**Table 1-5**) or the Richmond Agitation Sedation Scale (**Table 1-6**). Delirium in the intensive care unit (ICU) is measured with the Confusion Assessment Method for Assessing Delirium in the Intensive Care Unit (CAM-ICU) (**Figure 1-15**).

## Posturing

Patients with neurologic injury may demonstrate decerebrate or decorticate posturing (**Figure 1-16**). Decerebrate posturing may result from a painful

**TABLE 1-6**
**Richmond Agitation Sedation Scale (RASS)**

| Score | Term | Description |
|---|---|---|
| +4 | Combative | Overtly combative, violent, immediate danger to staff |
| +3 | Very agitated | Pulls or removes tube(s) or catheter(s), aggressive |
| +2 | Agitated | Frequent nonpurposeful movement, fights ventilator |
| +1 | Restless | Anxious, but movements not aggressive or vigorous |
| 0 | Alert and calm | |
| −1 | Drowsy | Not fully alert, but has sustained awakening (eye opening/eye contact) to voice (≥10 seconds) |
| −2 | Light sedation | Briefly awakens with eye contact to voice (<10 seconds) |
| −3 | Moderate sedation | Movement or eye opening to voice (but no eye contact) |
| −4 | Deep sedation | No response to voice, but movement or eye opening to physical stimulation |
| −5 | Unarousable | No response to voice or physical stimulation |

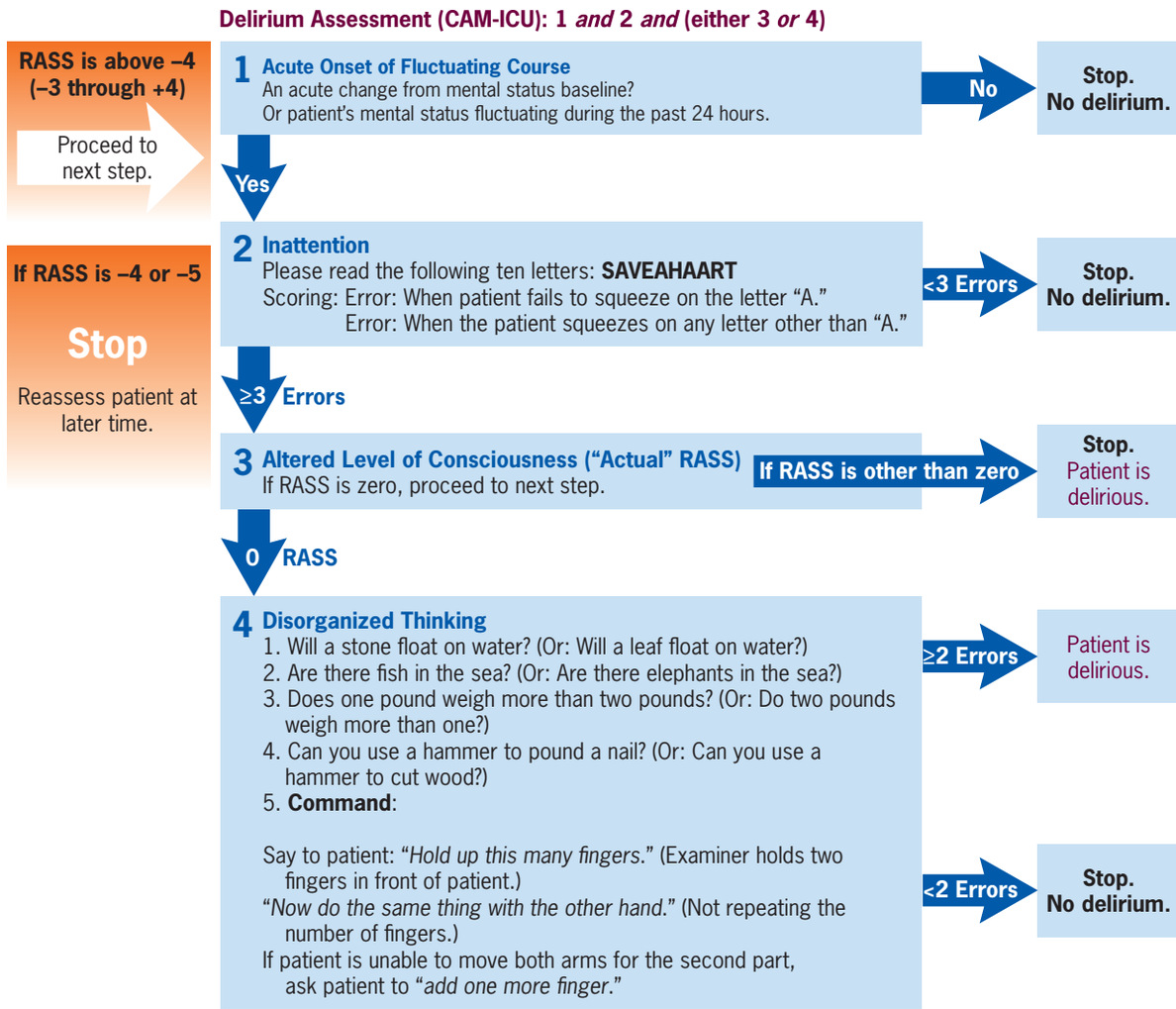


**FIGURE 1-15** Confusion Assessment Method for Assessing Delirium in the Intensive Care Unit (CAM-ICU).

Reproduced from Guenther U, Popp J, Koecher L, et al. Validity and reliability of the CAM-ICU flowsheet to diagnose delirium in surgical ICU patients. *Crit Care.* 2010;25:144–156. Copyright 2010, with permission of Elsevier.

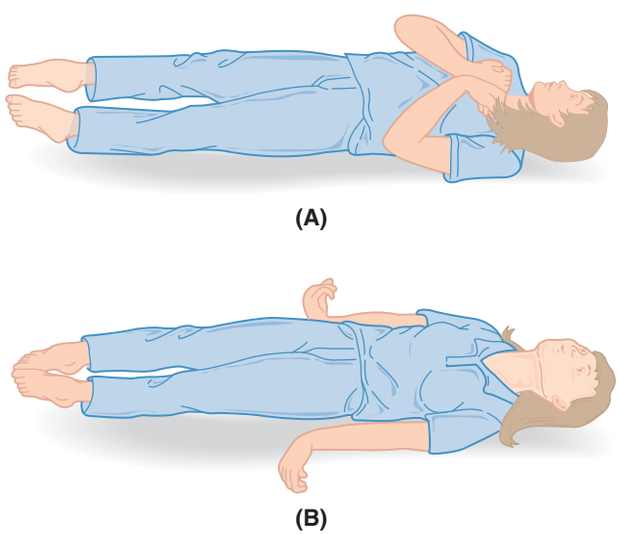


**FIGURE 1-16** (**A**) Decorticate posturing. (**B**) Decerebrate posturing.

stimulus of a comatose patient with low-level brain stem compression. The patient responds with extension and internal rotation of the arms and extends the legs. Decorticate posturing results when a painful stimulus is applied to a comatose patient with a lesion in the mesencephalic region of the brain. In response to the stimulus, the patient rigidly flexes the arms at the elbows and wrists. The legs may be flexed as well.

## Pupillary Dilation

Pupillary dilation (**Figure 1-17**) can occur with cerebral edema and brain stem compression. Because pupillary dilation is related to compression of the oculomotor nerve, the pupil will be dilated *on the same side* as the causative brain lesion. Either dilation or constriction of the pupils can also be associated with the administration of some medications.

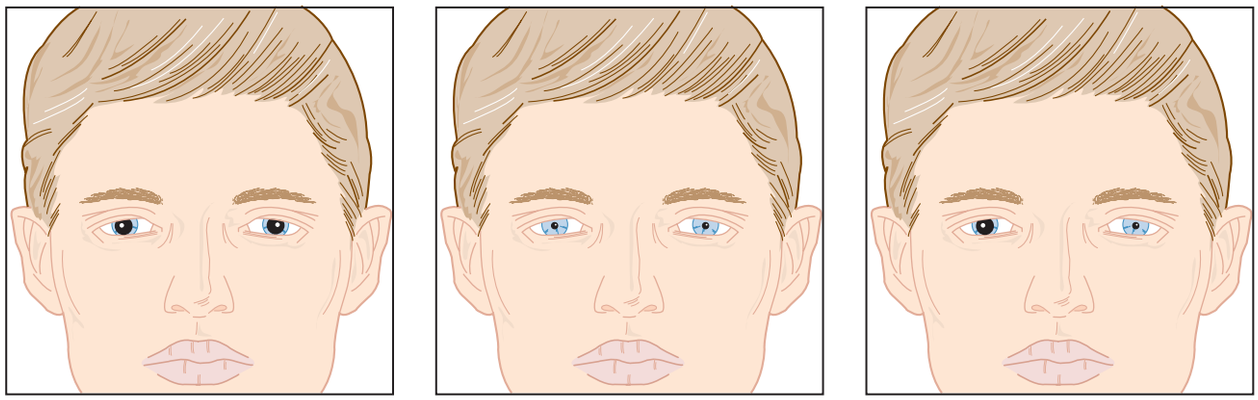


**FIGURE 1-17** (**A**) Dilated pupils. (**B**) Constricted pupils. (**C**) Unequal pupils.

## Key Points

- The health history provides a detailed, chronologic record of the patient.
- The HPI offers a description of the onset of the problem, whether it developed suddenly, and the setting in which it developed.
- The four examination techniques commonly used are inspection, palpation, percussion, and auscultation.
- The use of accessory muscles implies an increased work of breathing.
- The assessment of respiratory expansion helps determine whether the lungs are expanding symmetrically.
- Auscultation of the chest allows assessment of diminished breath sounds, bronchial breath sounds, and adventitious breath sounds, such as crackles, rhonchi, wheezing, stridor, and pleural friction rubs.
- Listening to heart sounds involves notations of the rate and rhythm, extra heart sounds, and murmurs.
- The Glasgow Coma Scale is used to assess the level of consciousness.
- The level of sedation in critically ill, mechanically ventilated patients is often assessed with the Ramsay score or the Richmond Agitation Sedation Scale.
- Delirium is measured with the CAM score.

## Suggested Reading

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