JUSTIN SACCONE, a 15-year-old, failed to make his high school’s baseball team. Undaunted, the young man signed up to play for a neighborhood squad that was one player short on a particular Sunday afternoon. During the third inning, Justin stepped to the plate determined to get a hit. As the pitch was thrown, Justin squared around to bunt but was hit in the chest by the ball. He initially fell to the ground but soon got up and started to first base. Justin, however, never made it to the bag. He collapsed on the field and died. An autopsy revealed that he had suffered the fatal consequence of commotio cordis—a low-impact chest injury that interrupts the heart’s rhythm. (See: Eigelbach, “Family, Friends Mourn a Life Cut Short,” The Kentucky Post, September 26, 2003.)

Although Justin’s story is unusual, injuries to the chest caused by blunt trauma are not. If you have ever had the “wind knocked out of you” or sustained a bruised rib, you are painfully aware of the consequences of a minor chest injury. Blunt trauma to the thorax, however, can be life-threatening and includes multiple rib fractures that prevent normal respiration, a broken rib that punctures an internal organ, and a collapsed lung that requires the immediate insertion of a chest tube.

Thoracic injuries account for one quarter of all trauma-related deaths and play a role in up to one half of the remaining deaths. In the United States, about 16,000 deaths a year result from chest injuries. (Shahani & Galla, “Penetrating Chest Trauma,” eMedicine, http://www.emedicine.com/med/topic-2916.htm.) This chapter examines the anatomy of the thorax and provides an overview of some of the more common injuries that occur to this region.

ANATOMY OF THE CHEST • The chest represents that area of the body between the bottom of the neck and top of the abdomen (see Fig. 8-1). Many people refer to this anatomical region as the rib cage or thorax.
The chest is composed of the ribs, sternum, thoracic vertebrae, and fibrous tissues known as costal cartilage. These anatomical parts join together to form a rigid structure that protects a host of important internal organs.

The Ribs

The ribs are made up of 12 pairs of bones that are unequal in length. All of the bones are curved and extend from the spine to the front of the abdomen. The top seven sets of bones are known as "true ribs" and are attached to the breastbone or sternum by costal cartilage. Ribs numbered 8 through 10 are "false ribs" and do not contact the breastbone. Rather, they are secured by costal cartilage to the last rib that attaches to the sternum. The bottom two bones, or ribs 11 and 12, are "floating ribs." Although they attach to the spine in the rear, they are not secured together in the front.

A rib is made up of four parts: the head, neck, tubercle, and shaft, or body (see Fig. 8-2). The shaft is the largest part of this bone and represents the curved portion of the rib. The head forms that part of the rib that articulates, or joins up, with the thoracic vertebrae. The neck is the portion of the bone between the head and the curved surface of the rib. Each rib contains a tubercle or small projection at the junction where the rib’s neck and shaft meet. Its purpose is to provide an attachment site for the ligaments that hold the ribs together. (Nadalo & Jones, "Rib Fractures," eMedicine, www.emedicine.com/radio/topic609.htm.)

The Sternum

The sternum, or breastbone, is located in the middle part of the chest. This flat bone runs longitudinally and connects on the sides to the first seven ribs. The top part of this structure articulates with the starting points of the left and right collar bones.

The sternum is made up of three portions: the manubrium, body, and xiphoid process (see Fig. 8-3). The manubrium is the top and broadest part of the structure. The first rib and collarbone both connect to the manubrium. The body, or middle part, of the sternum constitutes the longest aspect and provides the connecting points for the second through the seventh ribs. The xiphoid process is the lowest portion of the sternum; it can be easily palpated and is shaped like the point of a knife. (See: Fisher, Gazzaniga, & Lastig, "Sternum Fractures," eMedicine, www.emedicine.com/radio/topic654.htm.)
The Thoracic Vertebrae

The posterior portion of the ribcage articulates with the thoracic vertebrae (see Fig. 8-4). This area consists of 12 bones that make up the largest part of the spine. Vertebrae T2 through T9 provide the attachment sites for the ribs. Because of this attachment to the ribs, they are not very mobile and are less likely to sustain trauma than the cervical or lumbar parts of the spine.

Costal Cartilage

Just as two pieces of wood must be secured together by nails, the bones in the chest must be anchored together by soft tissues. Costal cartilage is the fibrous band of connective tissue that secures the ribs to the sternum. Costal cartilage varies in size, depending upon the length of the rib to which it attaches. For instance, this fibrous tissue increases in length with each descending rib through the first seven. These soft tissue connectors also provide the chest wall with flexibility so it can move during respiration.

The Movement Of The Chest During Respiration

Many consider breathing to be the function of the mouth and lungs. Respiration, however, is much more complicated and also involves the diaphragm and ribs. The diaphragm, a large muscle that separates the abdominal and thoracic cavities, plays a vital role in the breathing process. With inhalation, the diaphragm contracts, creating a vacuum-like effect in the thoracic cavity. This phenomenon expands the lungs by filling them with air that is inhaled through the windpipe. The diaphragm relaxes when air is expelled, causing the lungs to contract. This process is very much like a balloon deflating when air is released. (“The Diaphragm, Ribs, and Breathing,” The Respiratory System, www.naturalhealthschool.com/diaphragm_breathing.html.)

The true ribs attach to the sternum, so they have little movement during respiration. Because the false ribs are held together by costal cartilage, this area of the chest enjoys a little more flexibility. The floating ribs, however, have no attachment in the front, so they have the greatest mobility.

Breathing requires several simultaneous movements to take place. As the chest expands, air is inhaled causing the ribs to elevate, or move upwards. At the same time, the middle portion of the lower ribs moves laterally. Medical literature notes that this movement mimics the actions of a bucket handle (see Fig. 8-5). The metal handle connects to the top of the bucket on each side. As it is lifted, the handle moves laterally and up in a unified fashion very much like the movement of the rib cage during respiration. When the upper ribs elevate, the front and back diameter of the rib cage increase similar to the movements of a pump handle that moves up and down (see Fig. 8-6). (“The Thoracic Cage/Respiration and Breathing,” www.courses.vcu.edu/DANC291-003/unit_4.htm)
INJURIES TO THE THORAX • The chest is susceptible to a variety of injuries, many of which can be life-threatening. This dire consequence occurs because a variety of important structures are located beneath the bones such as the ribs, sternum, lungs, heart, aorta, liver, and spleen. This part of the chapter focuses on chest injuries related to blunt trauma, because this type of force is the most frequent cause of thoracic injuries. Penetrating chest injuries, such as those caused by a gunshot or stab wounds, are not addressed.

Trauma to the chest occurs each day to 12 out of a million people, and one third of these victims require hospitalization. One event, however, accounts for 70% to 80% of all serious blunt chest injuries: motor vehicle accidents. (Sawyer, Sawyer & Jablons, “Blunt Chest Trauma,” eMedicine, www.emedicine.com/med/topic3658.htm.) Motorcycle operators are also susceptible to major chest injuries, with more than 26% of bike accidents resulting in this type of trauma. (Hitosugi et al., “Analysis of Fatal Injuries to Motorcyclists by Helmet Type,” 25 Am. J. Forensic Med. & Pathol. 125 (June 2004).) Presentation of symptoms varies from minor chest discomfort to shock, and the gravity of the injury is largely dependent upon the mechanism of trauma and the body part involved. (Sawyer, Sawyer & Jablons, “Blunt Chest Trauma,” eMedicine, www.emedicine.com/med/topic3658.htm.)

SOFT TISSUE TRAUMA TO THE CHEST • A direct impact to the thorax can result in discomfort, swelling, and bruising of the soft tissues. Ecchymosis results from a broken blood vessel that causes a disbursement of blood to the surrounding tissue. This is a common occurrence in rib injuries, but bruising does not interfere with breathing. The elderly are more susceptible to the development of black and blue marks, especially because certain medications they take for arthritis and heart problems can interfere with clotting.

Seat Belt Syndrome
Chest wall discomfort is a by-product of minor trauma to the soft tissue structures that make up the thorax. Bruising and discomfort are a frequent complication of the restraining forces caused by a seat belt in an accident. In fact, the term seat belt syndrome has been coined to describe this condition. Researchers have determined that minor chest injuries occur in about 30% of car crash victims as a result of the restraining loads exerted on a car’s occupant by a seat belt during a crash. (Hill, Mackay, & Morris, “Chest and Abdominal Injuries Caused by Seat Belt Loading,” Accid. Anal. & Prev. 1994 Feb.; 26(1):11-26.)

Intercostal Muscle Sprains
The intercostal muscles occupy the space between the ribs. Their function is to contract and pull the rib cage upward during breathing. These muscles can be strained by any movement that involves a forceful or extreme twisting of the body or by swinging the arms in a manner that occurs in tennis and golf. (“Rib Inju-