

# A Cross Country Collision

by  
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## Part I – Making up for Lost Time

Myra edged between two other moms along the rope that lined the cross country course. This would be the best place to see the runners as they climbed the final hill to the finish. It was her daughter Hannah's first season running at the college level and so far, she had done really well. Myra knew Hannah hoped to be near the front of the pack in this race, and she leaned against the rope as shouts from downhill signaled the arrival of the leading runners. Myra scanned the pack for Hannah, and... there! A flash of red hair and blue uniform. She was on pace for a PR (as a seasoned cross country mom, Myra knew that meant personal record).

She started to scream encouragement but was distracted by a dark blur that raced across the field toward the runners. She barely recognized the blur to be three deer before they plowed through the runners and into the adjacent tree line. It wasn't hard to recognize the runner that was thrown into the air upon impact with one of the deer; a runner with red hair and a blue uniform!

Myra didn't remember how she got to Hannah. She only remembered rudely shoving through the crowd gathered around Hannah, screaming her name. Hannah was sitting on the ground, dazed and slumped to one side. Myra searched for signs of a serious injury, but she was quickly pushed back as several emergency medical technicians (EMTs) and an athletic trainer surrounded Hannah. She could hear Hannah's labored breathing, a wet gasping sound punctuated with grunts of pain. It was awful to listen to. The EMTs worked quickly, murmuring medical jargon that meant nothing to Myra. They put a cervical collar on Hannah, and it wasn't long before they had her strapped to a backboard and loaded carefully onto the four-wheeled utility vehicle that would take her off the course. One of the EMTs explained to Myra that the hospital was only 10 minutes away so they would transport Hannah by ambulance and she should follow in her car. Myra only vaguely heard what he said; she was too frightened by Hannah's pale face, her gasping attempts to breathe, and the smear of blood on the side of her uniform shirt.

### Question

1. What potential injuries could Hannah have sustained when the deer hit her? Explain your choices.

## Part II – An Ugly Chest Wound

“Brent, trauma case arriving in 10 minutes! Make sure Bay 2 is ready.” Brent jumped at the sound of the charge nurse’s shout. He loved working as a nurse in the emergency department, especially on trauma cases. He’d only been on the job for a few months and there was always something to learn.

He double-checked the supplies in Bay 2, and listened carefully as the EMTs pushed the gurney into the room. “Hannah Ellis, 19-year-old female, hit by a deer while running. BP 100/80, pulse 108, respiration 23 breaths per minute and shallow. Sucking chest wound, chest seal applied in the field. No signs of tension pneumothorax. Minor lacerations, contusions, no obvious fractures. Pupils equal and reactive.”

“Hit by a *what?*” Brent shared a glance with Dr. Jada Harris, the chief resident, as he processed the EMT’s staccato report. Hannah’s vital signs weren’t surprising; her heart rate was a little high, as was her respiratory rate, but the reactive pupils lowered the chances of a severe head injury. The chest wound, on the other hand, could have some significant complications.

“Take some deep breaths for me, Hannah. Hmmm, no breath sounds on the injured side.” Dr. Harris turned to check the newly acquired X-rays on the monitor. “No evidence of a cervical spine injury... looks like a possible hairline fracture of the fourth rib though... and that’s one heck of a pneumothorax. Let’s roll her onto her side and check that wound.”

Brent assisted in turning Hannah onto her side, which elicited a yelp of pain. “Hurts,” she gasped.

Brent could see why. An ugly bruise was already forming on the lateral chest wall, and just below the inferior tip of her scapula was a ragged, two-inch laceration that extended deeply into her skin. The resident carefully peeled away the clear adhesive seal placed by the EMTs so she could get a better look. As soon as she did, Brent heard a gurgling, sucking sound each time Hannah inhaled, and a small amount of blood foamed at the edges of the wound.

Dr. Harris gently probed the wound, and Hannah howled. “Yep, all the way through the chest wall. Sorry, Hannah, I know this isn’t comfortable. I don’t feel any obvious puncture in the lung but I can’t be sure. How did that happen... penetrating wound but no lung injury... from a deer?”

Brent went hunting every year with his grandfather and had seen a lot of deer up close. “My guess is she got clipped by the tip of an antler on a young buck, or maybe the edge of a hoof. Either way, it must’ve hit just right not to cause more serious fractures or penetrate deeply enough to hit the lung. Hannah, you might not feel like it right now, but you’re pretty lucky.”

### Questions

1. What is a pneumothorax?
2. A normal chest x-ray is shown in Figure 1(A) (next page). Hannah’s X-ray probably looks similar to (B). Dense objects like bone and organs appear white, air-filled spaces are black, and the lungs are a mottled grey. Is the pneumothorax on the left or right side (remember that the patient is facing you so left and right are reversed)? How do you know?

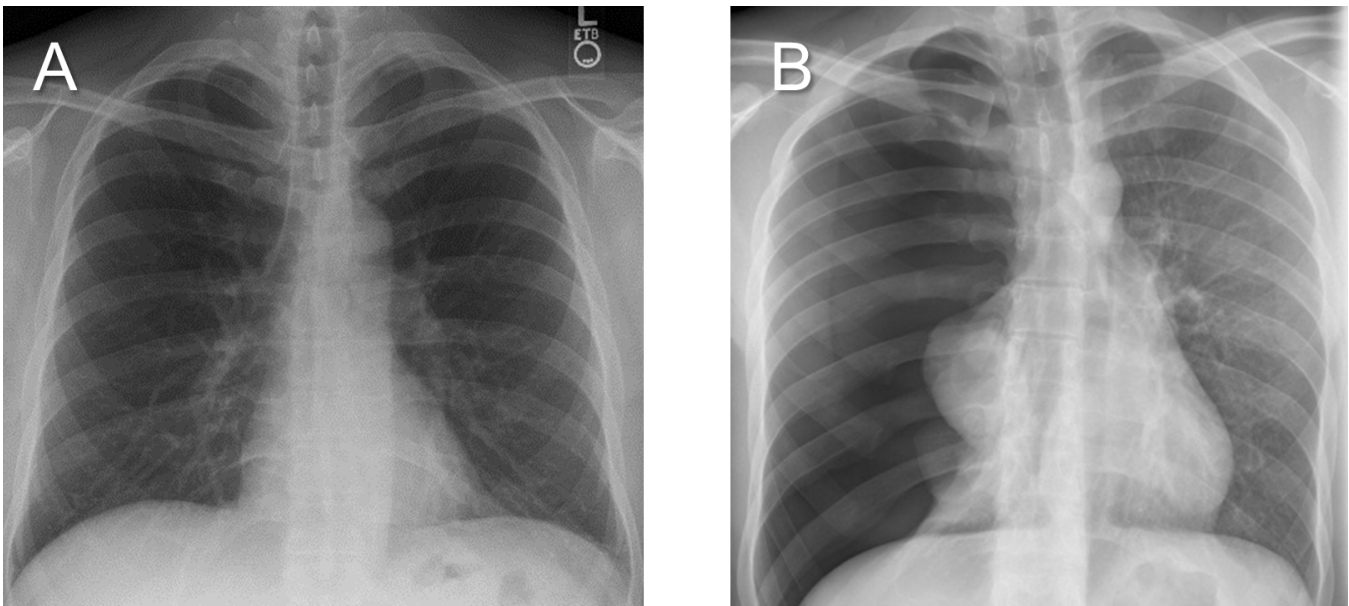


Figure 1. Panel A is a normal chest x-ray; Hannah's X-ray looks similar to Panel B. Credits: Panel A, PD. Panel B, Hellerhoff, CC BY-SA 3.0.

3. Will her pneumothorax spread to affect the other lung? Why or why not?
  
4. a. Describe the two factors that normally keep the lung inflated against the thoracic wall.
  
- b. How did the pneumothorax cause Hannah's lung to collapse?
  
5. When the adhesive seal was removed, why did Brent hear a sucking sound each time Hannah inhaled? What can you conclude about the pressure gradient between the atmosphere and the pleural cavity?

### Part III – A Tube in the Chest

“Can’t... breathe,” Hannah whispered between shallow breaths.

“I know, Hannah. We’re going to give you some supplemental oxygen, which should help until we get you into surgery,” Dr. Harris responded.

She replaced the seal across the wound and the sucking sound stopped; then she directed another nurse to alert the surgical team. “They’ll need to confirm there’s no injury to the lung, and remove any debris. They can do a better job of closing the wound, too. However, let’s go ahead and put in the chest tube here. She’ll need one anyway, and her blood pressure has dropped a bit. I don’t want this to turn into a tension pneumo before she gets to surgery.”

Brent knew that a tension pneumothorax occurs when air repeatedly enters the pleural cavity with each breath (in this case through Hannah’s wound), but cannot escape. The volume and pressure in the pleural cavity increase significantly and push the mediastinum to the opposite side, which can quickly lead to a fatal drop in blood pressure. The adhesive seal over the wound should prevent this from happening, but Brent knew Dr. Harris didn’t want to take any chances.

Brent quickly retrieved the tube thoracostomy tray. He had only assisted on a few chest tube insertions, and was glad to gain more experience. “Hannah, can you hear me? We’re going to put a tube in your chest to help you breathe better. It won’t take long, and we’re going to give you some medicine to help with the pain.” Hannah nodded and continued to gasp for breath.

Brent swabbed the lateral wall of Hannah’s ribcage with antiseptic, and watched as Dr. Harris injected local anesthetic into the fourth intercostal space, between the fourth and fifth ribs. A quick cut with a scalpel, and the tube was inserted and carefully stitched into place so that no air could leak out around it.

As Brent applied a bandage over the chest tube, the attending physician walked in for a report from Dr. Harris. While they conversed, Brent went to find Myra in the waiting room.

“Hannah’s headed up to surgery soon but you can come back and see her now.” He briefly explained Hannah’s injury. “The doctor is with her and will give you more details. Her outlook is good, although she’s not going to be out running any time soon.”

Relief passed across Myra’s face. “Oh, thank heavens. I thought that deer had done some permanent damage.”

#### Questions

1. Why will Hannah’s lung not re-inflate on its own when she inhales? Refer to the appropriate pressure gradients in your answer.
  
  
  
  
  
  
  
  
  
  
2. a. How will inserting a chest tube into the pleural cavity help to re-inflate her lung?  
  
  
  
  
  
  
  
  
  
  
b. Why did Dr. Harris avoid placing the chest tube inferior to the fifth intercostal space?

- c. A chest tube also requires careful placement *within* the intercostal space to avoid significant bleeding. Research or review the blood supply to the thoracic wall. On the diagram (Figure 2), draw a line in the intercostal space to represent where you think Dr. Harris made the incision. Explain why you placed it in that location.

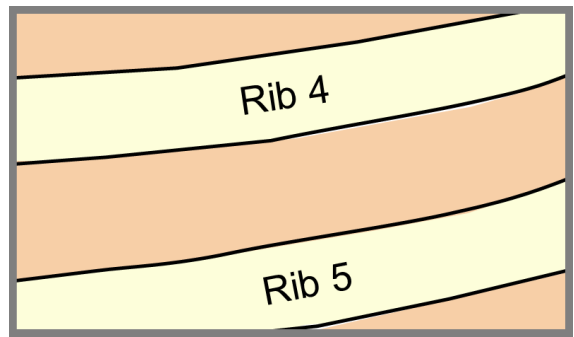


Figure 2. Diagram of ribs and intercostal space.

3. a. How is a tension pneumothorax different than a typical pneumothorax?
- b. Brent and Dr. Harris insert a chest tube to ensure that Hannah doesn't develop a tension pneumothorax (shown in B). Note the position of the heart compared to the normal x-ray in A. Review the cardiovascular structures in the mediastinum and explain how significantly increased volume and pressure in the pleural cavity could affect those structures to produce hypotension.

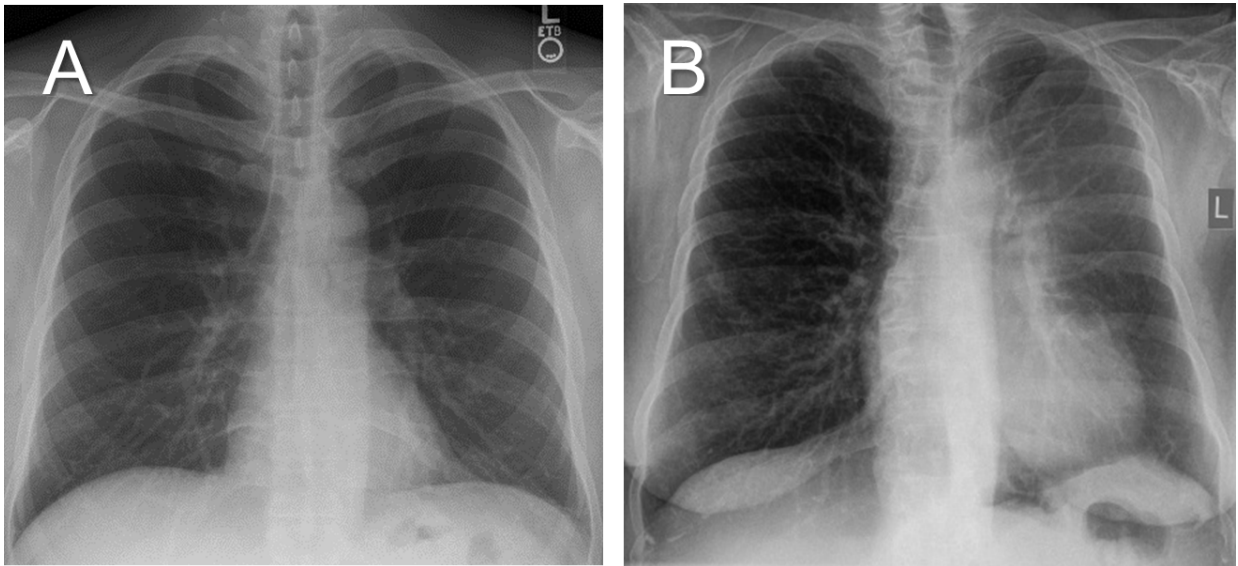


Figure 3. Panel A is a normal chest x-ray; B displays a tension pneumothorax. Credits: Panel A, PD. Panel B, Hellerhoff, CC BY-SA 3.0.

- c. A tension pneumothorax can be fatal if not treated quickly. What would you do if you didn't have a chest tube available or didn't have time to insert one?