

## Trauma *Topic of the Month*

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### Prehospital Needle Decompression for Suspected Tension Pneumothorax

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Pneumothorax is the presence of air in the thorax between the chest wall and the lungs themselves. The thorax can be pictured as two separate cavities, each containing one lung, and separated by the mediastinum, a structure that contains the heart and other large vessels. As this pocket of air increases in the size, it causes compression of other structures in the chest because the chest has a fixed size. This pocket of air can increase in size to the point where it collapses the lung on the same side and pushes the mediastinum towards the other side, while also compressing the lung on the opposite side. The mediastinum can be shifted to the point that the major veins bringing blood back to the heart, the superior vena cava and the inferior vena cava, are compressed. This decreases the return of blood to the heart, which naturally causes a decrease in cardiac output. This will cause a drop in blood pressure as well as oxygen saturation. Pneumothorax is the presence of air in the hemithorax outside of the lung, but it becomes classified as a tension pneumothorax when blood pressure or oxygenation decrease, a life threatening situation.

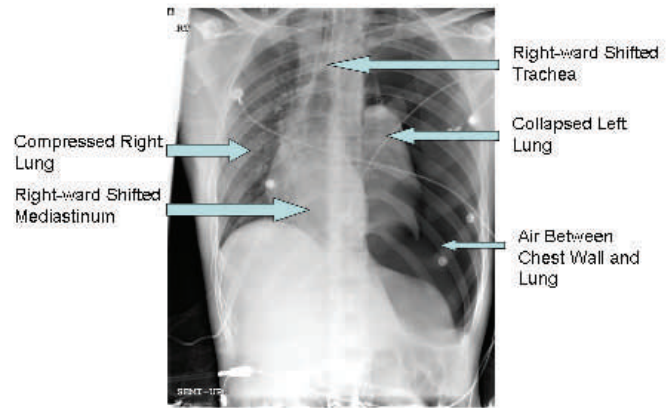
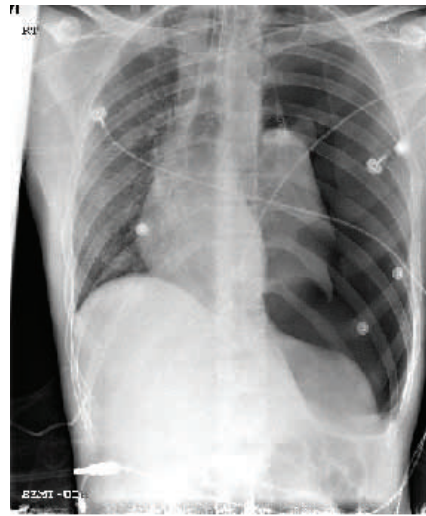
There are many causes of pneumothorax, most commonly from trauma. Blunt and penetrating trauma can both cause pneumothorax. Blunt trauma most commonly causes pneumothorax by way of rib fractures injuring the lung parenchyma, whereas penetrating trauma can more easily damage the lung parenchyma itself. Pneumothoraces can also occur spontaneously, such as when a lung bleb in a patient with emphysema ruptures. All 3 mechanisms can lead to pneumothoraces by way of air leaking from the respiratory tree into the hemithorax, between the lung and the chest wall. Penetrating trauma can also lead to pneumothorax by creating a passageway for air to travel from outside of the patient through a chest wound and into the hemithorax.

Hemothorax is a similar situation where blood fills the space between the lung and the chest wall. This can also increase in size to the point where the mediastinum is shifted, causing tension hemothorax. This can occur from bleeding of vessels within the lung after trauma, or from bleeding in the chest wall that seeps into the hemithorax. This can also occur from bleeding from the great vessels supplying and draining the heart.

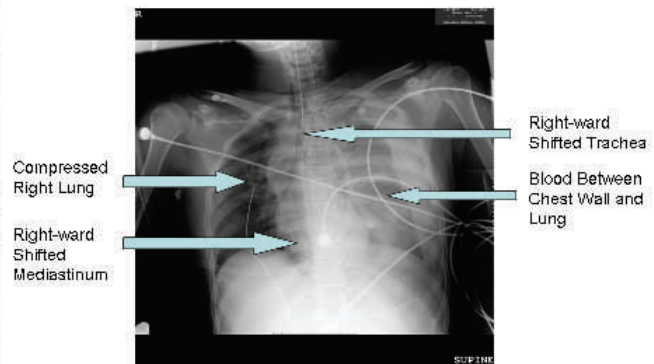
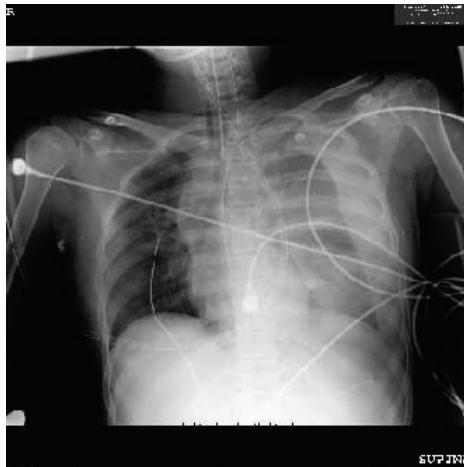
Both hemothorax and pneumothorax are easily detected by chest xray, but are more difficult based on physical exam alone. Unfortunately, in the prehospital setting, xray is not available and physical exam along with a patient's vital signs much guide treatment in the event that tension pneumothorax or hemothorax develop.

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**Fig 1. Tension Pneumothorax**

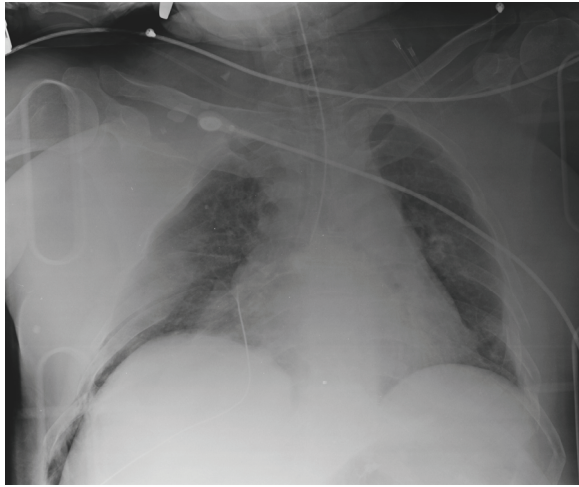


**Fig 2. Tension Hemothorax**

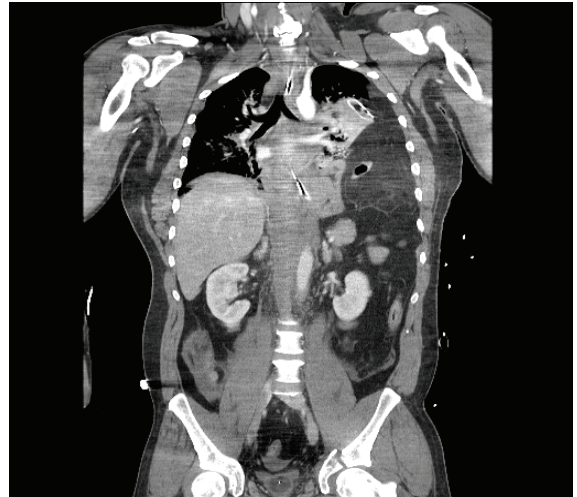
Physical exam findings for both pneumothorax and hemothorax will cause decreased breath sounds on the affected side, but a pneumothorax will be tympanic to percussion, while a hemothorax will be dull to percussion. As tension physiology develops, the trachea may become deviated away from the affected side and the patient's blood pressure and/or oxygen saturation will drop. When the systolic blood pressure is less than 90mmHg or the oxygen saturation is less than 90%, a patient with suspected pneumothorax requires intervention. Decreased breath sounds on one side with systolic blood pressure above 90mmHg and oxygen saturation greater than 90% do not require emergent treatment in the prehospital setting. Careful assessment must be performed on intubated patients, as a right mainstem intubation can create a false picture consistent with tension pneumothorax. A right mainstem intubation will lead to decreased left chest breath sounds as well as decreased oxygenation, and possibly hypotension with large tidal volumes are given via mechanical assistance. Diaphragmatic rupture can also create a similar picture.

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**Fig 3. Right Mainstem Intubation**



**Fig 4. Diaphragmatic Rupture**

Initial treatment for tension pneumothorax in the prehospital setting is needle decompression. The technique for performing needle decompression is relatively simple, but can have dire consequences. The site of decompression for tension pneumothorax is in the 2nd or 3rd intercostal space in the midclavicular line. To find this space, you must remember that the first palpable rib on the patient's anterior chest is the 2nd rib, the needle, preferably 14 gauge, should be inserted in the intercostal space directly under this rib in line with the middle of the clavicle, or the space beneath the next palpable rib, the 3rd rib. A needle must be selected that is long enough to penetrate through the patient's chest wall, a study at Carolinas Medical Center found that the standard 4.4cm (2inch) needles would be unsuccessful in 50% of patients<sup>1</sup>. Obese or muscular patients may require longer needles. It must be kept in mind that a longer needle will have increased risk of penetrating other vital structures during decompression<sup>2</sup>. If available, the area should be prepped with antiseptic material prior to decompression. An angiocath should be placed over the needle and attached to a syringe. The syringe plunger should be used to perform aspiration as the needle and angiocath are inserted perpendicular to the skin. Once both needle and angiocath are inserted together, air should flow out of the needle, which can then be removed leaving the angiocath in place. To prevent reentry of air, a 1-way valve should be applied to the external end of the angiocath, such as a Heimlich valve. If a valve is not available, the finger of a rubber glove with its tip removed may serve as a makeshift 1-way valve. The finger of the rubber glove is used by passing the needle and angiocath through the glove prior to insertion. Once needle decompression is performed, definitive treatment with a larger, formal chest tube can be performed in the hospital setting.



**Fig 5. Heimlich Valve**



**Fig 5. Needle Decompression**

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Potential pitfalls of needle decompression include creating a pneumothorax by introducing air into the chest, damaging a noncollapsed lung or part of the bronchial tree which can lead to a pneumothorax, or reintroducing air into the chest after decompression by not using a 1-way valve. Inserting a needle blindly into the chest can also damage veins, arteries, or even the heart itself; these vital structures, when damaged, can lead to rapid and massive accumulation of blood in the chest, as well as death. Lastly, bacteria and other microbes can be introduced into the chest with needle decompression, either by directly bringing them into the chest with an unsterile field or unsterile instruments, as well as by providing a route for external microbes to enter the chest after placement. This can lead to chest infection and eventual empyema, a potentially life-threatening complication.

In summary, needle decompression can be lifesaving in the situation of tension pneumothorax, but it can also have dire consequences. It is a vital procedure in our armamentarium because of this lifesaving capability. Because of the potential pitfalls, it must be only performed in appropriate patients, with correct instruments and technique, to limit the negative side effects. In the prehospital setting, careful assessment must be used to identify those who meet the criteria of suspected pneumothorax with hypotension or hypoxia in order to perform needle decompression in the appropriate patients.

#### **KEY POINTS:**

1. Recognize signs and symptoms of tension pneumothorax
2. Perform needle decompression with the right technique in the right location
3. Don't put a needle in someone who doesn't need it- rule out other causes of decreased breath sounds, hypoxia, and hypotension

#### References:

1. Stevens, Robert L., Rochester, Angel A., Busko, Jonathan, Blackwell, Thomas, Schwartz, Daniel, Argenta, Anne and Sing, Ronald F.(2009)'Needle Thoracostomy for Tension Pneumothorax: Failure Predicted by Chest Computed Tomography',*Prehospital Emergency Care*,13:1,14 — 17
2. Butler KL, Best IM, Weaver WL, Bumpers HL. Pulmonary artery injury and cardiac tamponade after needle decompression of suspected tension pneumothorax. *J Trauma*. 2003;54(3):610-1.