

## Tension Pneumothorax Simulation Case

- I. **Title: Tension Pneumothorax vs. Traumatic Brain Injury: Avoiding Premature Closure in Assessment of a Pediatric Trauma Victim**
- II. **Target Audience:** residents, nurses, medical students, respiratory therapists, pharmacists
- III. **Learning Objectives or Assessment Objectives**
  - a. Primary
    - i. To demonstrate an appropriate primary assessment of an adolescent trauma victim.
    - ii. To obtain appropriate laboratory and radiology studies.
    - iii. To recognize and treat decompensation due to tension pneumothorax.
    - iv. To avoid premature closure and continue to evaluate all possible etiologies for patient condition.
  - b. Secondary
    - i. Know the clinical findings and appropriate management of tension pneumothorax
  - c. Critical actions checklist
    - i. Assign roles prior to arrival of trauma patient
    - ii. Perform appropriate primary assessment of adolescent trauma victim
    - iii. Obtain IV access, administer oxygen, and connect patient to continuous cardiorespiratory monitoring
    - iv. Perform focused H&P
    - v. Obtain appropriate labs and imaging
    - vi. Correctly initiate PALS resuscitation
    - vii. Recognize ongoing tension pneumothorax based on exam findings and patient presentation
    - viii. Initiate appropriate management (needle decompression); find landmarks
    - ix. Perform appropriate secondary assessment of adolescent trauma victim
- IV. **Environment**
  - a. Lab Set Up – Trauma Bay
  - b. Manikin Set Up
    - i. Adolescent/Adult type manikin with monitor available
    - ii. IV access: L arm peripheral IV
    - iii. Moulage:
      1. R temporal cranial trauma with some frank bleeding
      2. Large bruises on anterior and L chest
  - c. Props
    - i. CXR: see Appendix A
    - ii. CT Head: see Appendix A
    - iii. Labs available on request: see Appendix B
    - iv. Decompression needle (18 gauge)
    - v. Thoracostomy tube
  - d. Distractors – None

## V. Actors

- a. Roles – Nurse
- b. Who may play them – trained simulation center staff or simulation participant who has been briefed with correct findings prior to start
- c. Action Role –nurse may assist with obtaining physical exam findings and administering medications
  - i. Prompt team to obtain imaging and/or labs if they neglect to do this after obtaining an H&P. Notify them that certain imaging orders may take time to come back.
  - ii. PE Findings (for states see scenario branch points below)
    1. **State 1:** “His neck veins look distended”
    2. **State 2:** “Cap refill is >3 seconds,” “chest expansion doesn’t look like it did before”

## VI. Case Narrative (describes what the learner will experience)

- a. Scenario Background Given to Participants
  - i. Prebrief Information: Notify learners of capabilities/limitations and simulation options, including obtaining labs and imaging. Acknowledge that some events (labs, imaging) may happen in compressed time compared to reality. Inform group that labs and imaging data may change in the course of the simulation.
  - ii. Scenario brief: Patient involved in MVA three blocks from hospital is currently en route to trauma bay. You may perform any essential team preparation now (give team a moment to assign roles).
- b. EMS Report
  - i. Given freely by EMS on arrival of patient: William Jackson is a 16 YOWM unrestrained driver involved in a head-on MVA three blocks from the hospital. EMS found him slumped over the steering wheel. Air bags were not deployed. **Patient was able to be aroused and 6cm R sided scalp laceration with active bleeding noted**; sterile gauze and pressure were applied en route to ED. Patient is awake, alert, and complaining of pain around head laceration site. He has been breathing deeply during transport. Bruises are also noted on chest wall.
- c. Past medical history: unknown
- d. Meds and allergies: patient denies any allergies
- e. Family/social history: unknown
- f. Scenario conditions initially
- g. History patient gives: see vocalizations below
- h. Patients initial exam:
  - i. Gen: patient in distress, airway intact, breathing spontaneously and deeply
  - ii. Vitals: See below
  - iii. HEENT: normocephalic, PERRL, 6cm R sided scalp lac, no JVD
  - iv. Resp: breath sounds equal BL
  - v. CV: tachycardic with no m/r/g
  - vi. Abd: NBS all 4 quads, no TTP
  - vii. Extremities: no gross deformities, withdraws to pain
  - viii. Neuro: GCS 15, localizes painful stimuli
- i. Scenario branch points

Baseline				Time: 0 - 2 min.				Sounds		
HR	Rhythm	BP	O2 Sat	RR	Pulses	Temp	Eyes	Lung	Heart	Bowel
110	Sinus	138/86	97	23	Normal	98.8	PERRL	Normal BL	Normal	Normal
<b>Patient vocalizations:</b> Patient should act <u>groggy</u> Groans... "owww man my head." "Everything after the crash was a blur and I blacked out." "My chest hurts bad." If chest wall is palpated, "OUCH!"										
<b>Expected learner actions:</b> Perform primary assessment, attempt focused H&P from patient, monitor vitals, possibly choose to obtain head CT.										
<b>Operator notes/prompts:</b> Try to emphasize/distract the team with the cranial injury and possibility for TBI; provide head CT around 30 seconds after request which shows only minor subcutaneous hematoma 2/2 scalp lac, provide labs.										
<b>Transition to next state:</b> Team investigates PTX or continues to investigate for possible TBI or other etiologies										

State 1: Tension PTX exacerbate				Time: 2 – 5 min				Sounds		
HR	Rhythm	BP	O2 Sat	RR	Pulses	Temp	Eyes	Lung	Heart	Bowel
130-150	Sinus tachy	105/79	89	32	Bounding	98.8	PERRL	Absent L BS	Normal	Normal
<b>Patient vocalizations:</b> "I feel like I'm out of breath"... "my chest really hurts"... more groaning.										
<b>Expected learner actions:</b> Check breath sounds/other PE findings, obtain CXR, if tension PTX is identified on initial										
<b>Operator notes/prompts:</b> Provide CXR #1 (mild severity tension PTX)										

State 2: Decompensation				Time: 5-10 min.				Sounds		
HR	Rhythm	BP	O2 Sat	RR	Pulses	Temp	Eyes	Lung	Heart	Bowel
170	Sinus tachy	85/50	74	55	Bounding/PE A	98.8	PERRL	Absent L BS	Distast	Normal
<b>Patient vocalizations:</b> Patient becomes silent										
<b>Expected learner actions:</b> Identify tension PTX, place needle thoracostomy, begin PALS										
<b>Operator notes/prompts:</b> Provide CXR #2 (severe tension PTX evident with mediastinal/trachial shift); if repeat CT scan is requested, provide the same scan as before.										
<b>Transition to next state:</b> Team successfully places needle thoracostomy/chest tube										

State 3: Recovery phase				Time: 10-15 min.				Sounds		
HR	Rhythm	BP	O2 Sat	RR	Pulses	Temp	Eyes	Lung	Heart	Bowel
120	Sinus	125/80	96	25	Normal	98.8	PERRL	Normal BL	Normal	Normal
<b>Patient vocalizations:</b> "What happened?"										
<b>Expected learner actions:</b> Reassure patient, consult thoracic surgery, transfer pt to PICU										
<b>Operator notes/prompts:</b> Provide resolution CXR; Stop scenario										

## **VII. Debriefing Plan**

- a. Method of debriefing – Group debriefing
- b. Reactions
  - i. How did that feel?
  - ii. What worked well?
  - iii. What didn't feel right or went poorly?
- c. Opening Statement: This was a patient who was involved in a MVA without air bag deployment resulting in significant chest wall trauma with L sided rib fractures, which resulted in lung laceration. This laceration allowed air to leak out into the pleural space and progressively compress mediastinal structures, causing cardiovascular collapse and hypoxia. We will briefly discuss the primary assessment of a pediatric trauma patient, followed by examining the presentation and management of tension pneumothorax, and finally how the concept of premature closure can occur in the workup of a trauma.
- d. Primary assessment
  - i. What were the ABCDE's of this case?
  - ii. Would anyone like to share a working differential diagnosis that they developed for this patient?
- e. Tension Pneumothorax
  - i. See appendix C
- f. Premature Closure
  - i. Did anyone feel they became focused on a particular diagnosis early in the case?
  - ii. What are some strategies that can be implemented to avoid premature closure?

## **VIII. Pilot Testing and Revisions**

- a. Numbers of participants: 18
- b. Additional scenario options for non-trauma settings:
  - i. Option A: Emergency department (non-trauma bay setting)
    - 1. Scenario adjustments: patient fell from roof and suffered only moderate chest bruising due to impact without cranial trauma/moulage as described above. Was brought in to the ED by parent and is initially in only experiencing mild localized chest pain.
    - 2. Objective: With this adjustment the primary focus is on the more gradual evolution of a tension pneumothorax over time due to pulmonary contusion, without the confounding cranial trauma. It allows for a more slow-paced simulation in which the team can develop a complete differential diagnosis for the presentation and workup appropriately. This simulation variant might be more appropriate for medical students and other less experienced participants.
  - ii. Option B: PICU
    - 1. Scenario adjustments: patient involved in MVA with numerous skin contusions and significant blood loss with development of decompensated hypovolemic shock was recently admitted to PICU after resuscitation in trauma bay with fluids and blood products. He initially required intubation while in the trauma bay, and was sufficiently stabilized to allow for admission to PICU. The patient

proceeds to develop barotrauma secondary to pulmonary contusion exacerbated by positive pressure ventilation. During the case, he rapidly develops hypotension, tachypnea, and falling oxygen saturation levels.

2. Objective: with this adjustment the team is presented with a patient who has already undergone extensive interventions, including receiving blood products, and they must rapidly incorporate this information into their assessment of the patient and development of a differential diagnosis.

- c. Evaluation form for participants: Standard Children's of Alabama Simulation Center evaluation form

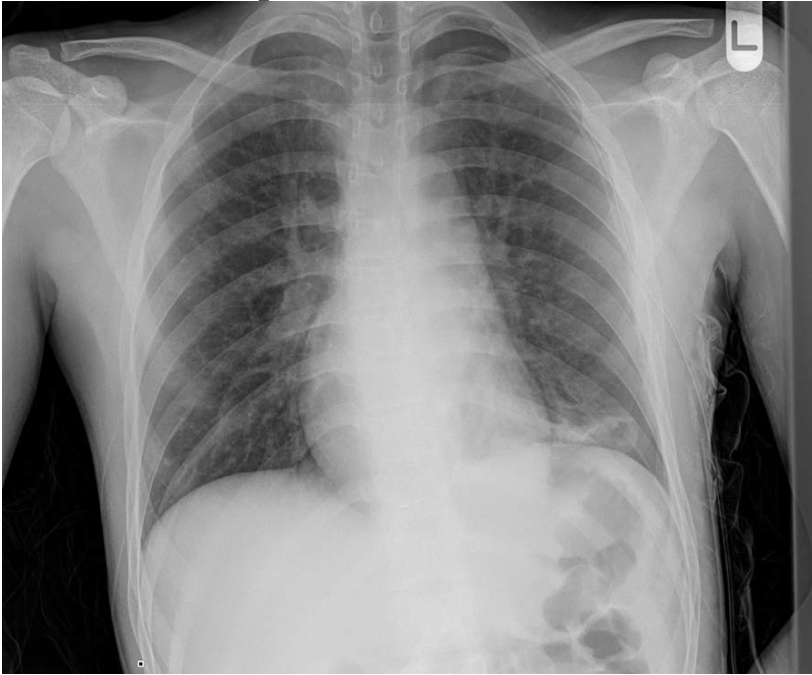
**IX. Authors**

- a. McDonald, JM
- b. White, ML

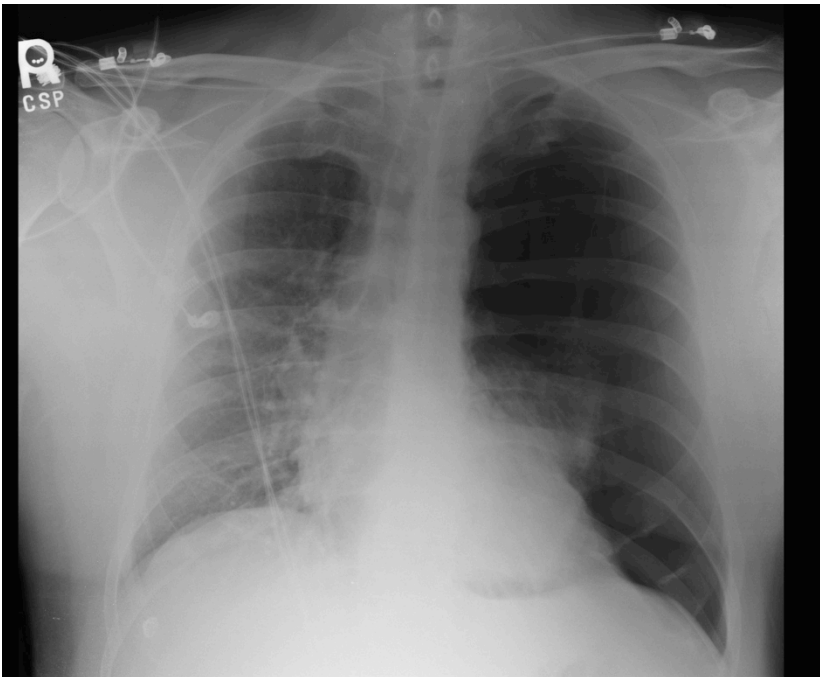
**X. References**

- a. <http://www.trauma.org/index.php/main/article/199/>
- b. [http://www.emedu.org/\(S\(rnw1rpi2cdyefu453tlnudeg\)\)/simlibrary/suppdowload.aspx?UploadID=159&AspxAutoDetectCookieSupport=1](http://www.emedu.org/(S(rnw1rpi2cdyefu453tlnudeg))/simlibrary/suppdowload.aspx?UploadID=159&AspxAutoDetectCookieSupport=1)

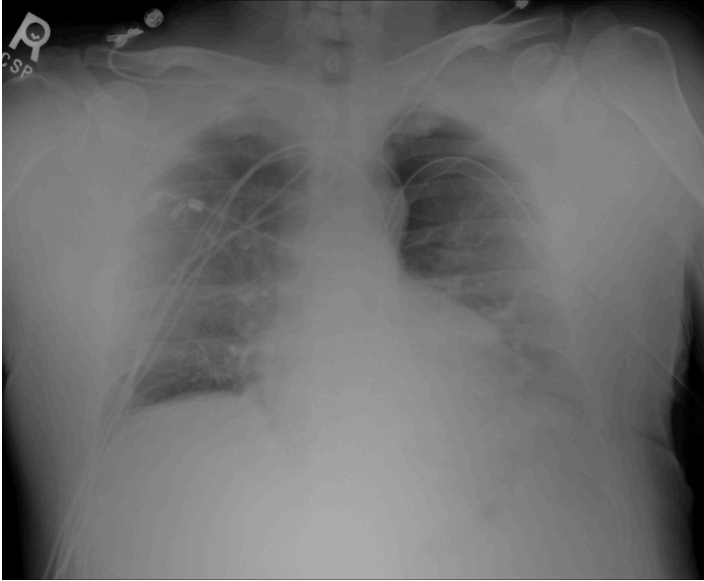
**Appendix A: Imaging**  
**CXR #1: Initial presentation**



**CXR #2: Tension PTX**



**CXR #3: Resolution**



**CT Head:**



## **Appendix B: Labs**

EPOC:

<b>pH</b>	7.28
<b>pCO<sub>2</sub></b>	25
<b>pO<sub>2</sub></b>	100
<b>Na<sup>+</sup></b>	138
<b>K<sup>+</sup></b>	4.5
<b>iCa<sup>++</sup></b>	1.2
<b>Hct</b>	37.2
<b>Glu</b>	98
<b>Lac</b>	3.4

CBC: 7.0>13.1/37.2<380

## **Appendix C: Debriefing Materials**

Tension pneumothorax is the progressive build-up of air within the pleural space, usually due to a lung laceration, which allows air to escape into the pleural space but not to return. Positive pressure ventilation may exacerbate this 'one-way-valve' effect.

Progressive build-up of pressure in the pleural space pushes the mediastinum to the opposite hemithorax, and obstructs venous return to the heart. This leads to circulatory instability and may result in traumatic arrest.

The classic signs of a tension pneumothorax are deviation of the trachea away from the side with the tension, a hyper-expanded chest, an increased percussion note and a hyper-expanded chest that moves little with respiration. The central venous pressure is usually raised, but will be normal or low in hypovolemic states.

Commonly, the patient is tachycardic and tachypneic, and may be hypoxic. These signs are followed by circulatory collapse with hypotension and subsequent traumatic arrest with pulseless electrical activity (PEA). Breath sounds and percussion note may be very difficult to appreciate and misleading. Tension pneumothorax may develop insidiously, especially in patients with positive pressure ventilation. This may happen immediately or some hours down the line. An unexplained tachycardia, hypotension and rise in airway pressure are strongly suggestive of a developing tension.

A tension pneumothorax may develop while the patient is undergoing investigations, such as CT scanning or operation. Whenever there is deterioration in the patient's oxygenation or ventilatory status, the chest should be re-examined and tension pneumothorax excluded.

Classical management of tension pneumothorax is emergent chest decompression with needle thoracostomy. A 14-16G intravenous cannula is inserted into the second rib space in the mid-clavicular line. The needle is advanced until air can be aspirated into a syringe connected to the needle. The needle is withdrawn and the cannula is left open to air. An immediate rush of air out of the chest indicates the presence of a tension pneumothorax. The manoeuvre essentially converts a tension pneumothorax into a simple pneumothorax.