

**American College of Physicians - Internal Medicine Meeting 2024  
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**Teaching Bedside Clinical Skills in the 21st Century**

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### **Objectives:**

By the end of this session, learners will be able to:

1. Understand the importance of observation in the assessment of respiratory status
2. Accurately identify surface landmarks and chest anatomy
3. Appropriately perform various percussion techniques and understand the significance of abnormal findings
4. Understand the significance of fremitus and how changes in fremitus signify potential abnormalities

*Note: In order for this session to be most effective, you will need a healthy volunteer who is comfortable removing their shirt. Ideally, the volunteer will be in reasonably good shape to allow easy identification of surface landmarks. Ask the volunteer if it is ok to write on their skin with a non-permanent marking pen as this will aid in the surface anatomy portion of the session. If they are not comfortable with the marking pen, be prepared to use paper tape to illustrate your anatomy points. If a volunteer is not available, you can try to find an inpatient who is willing to participate in the session.*

## **Observation**

Observation is the cornerstone of most physical examination maneuvers and will uncover obvious and even subtle abnormalities within the respiratory system.

- **Speaking/walking**
  - If possible, walk your patient back from the waiting room in clinic – this provides information about neuromuscular function, conditioning, overall functional status
  - Observe your patient while speaking – Do they speak in full sentences? Do they have to stop and catch their breath? Do they become dyspneic or cyanotic?
- **Respiratory rate** (*you can ask your volunteer to intentionally breathe fast as an example*)
  - Respiratory rate can be a powerful predictor of significant illness
  - RR of 27 predicts cardiac arrest on the wards<sup>1</sup>
  - 21% of ward patients with a RR 25-30 died in the hospital<sup>2</sup>
  - >50% of patients who suffer serious adverse event have RR>24<sup>3</sup>
  - Flash mob study showed that “recorded” RR are higher than actual rates and 18-20 is the most commonly “recorded” number<sup>4</sup>
- **Accessory Muscle Use**
  - Contraction of the sternocleidomastoids and external intercostals signifies increased respiratory load

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<sup>1</sup> Fieselmann JF, Hendryx MS, Helms CM, et al. Respiratory rate predicts cardiopulmonary arrest for internal medicine patients. *J Gen Intern Med* 1993; 8: 354-360.

<sup>2</sup> Subbe CP, Davies RG, Williams E, et al. Effect of introducing the Modified Early Warning score on clinical outcomes, cardiopulmonary arrests and intensive care utilisation in acute medical admissions. *Anaesthesia* 2003; 58: 797-802

<sup>3</sup> Goldhill DR, McNarry AF, Mandersloot G, et al. A physiologically-based early warning score for ward patients: the association between score and outcome. *Anaesthesia* 2005; 60: 547-553

<sup>4</sup> Semler MW<sup>1</sup>, Stover DG, Copland AP, Hong G, Johnson MJ, Kriss MS, Otepka H, Wang L, Christman BW, Rice TW. Chest. 2013 Jun;143(6):1740-4. doi: 10.1378/chest.12-1837.

➤ **Abdominal paradox**

Ask participants to place one hand on chest and one hand on abdomen and take in several deep breaths

- In normal respiration, the abdomen should bow outward because intra-abdominal pressure rises as the diaphragm contracts and bows downward.
- If the diaphragm is fatigued, or if the respiratory load is too high, the abdomen will be sucked inward (“abdominal paradox”) as the accessory muscles and intercostals become the predominant drivers of decreasing intrathoracic pressure. The diaphragm will not contract and pull downward and will instead be sucked up into the chest, so intra-abdominal pressure falls during inspiration.
- LR 3.2 for detecting bilateral diaphragmatic paralysis
- Respiratory alternans might also occur – intermittent paradox vs. normal breathing

➤ **Symmetry of Chest Expansion**

- Place both hands on back and then lateral aspect of chest and feel the movement of your fingertips.
- Asymmetric chest expansion is indicative of unilateral disease, particularly pneumonia or pleural effusion.

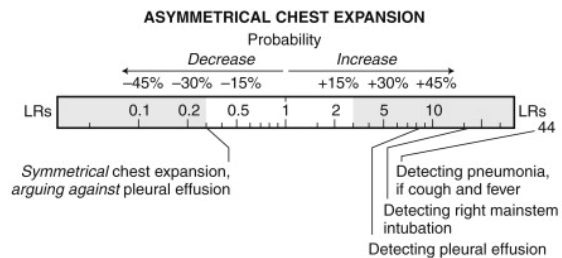


Figure 1. From McGee's Evidence-Based Physical Diagnosis, Chapter 27

➤ **Hoover's sign**

- Normally the ribcage should move outward as the diaphragm contracts
- If the diaphragm is flattened from hyperinflation, it will pull the ribcage inwards
- LR 4.2 for detecting COPD

**Surface anatomy**

Using your volunteer, point out (and mark) the following anatomic landmarks

➤ **Angle of Louis**

- Articulation of 2<sup>nd</sup> rib to the sternum
- Importance of angle of Louis
  - right atrium
  - Trachea bifurcation
  - Lower border of T4 vertebral body (posteriorly)
  - Point at which the thoracic duct crosses over
  - Reference point for jugular venous pressure measurement

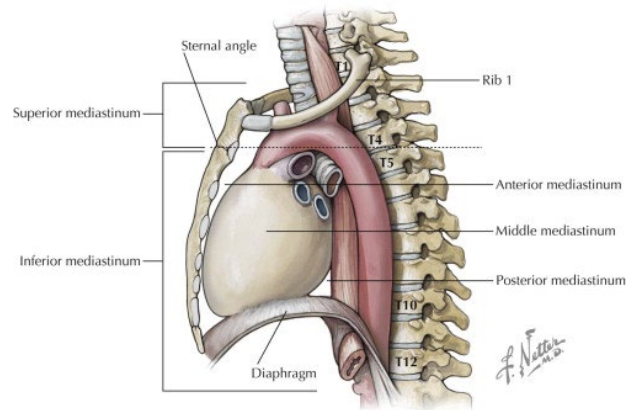


Figure 2. From Netter's Clinical Anatomy, Chapter 3

➤ **Major fissure and Minor fissure (on right side)**

- Trace the major fissure
  - Place your subject's hand on his/her head and trace the outline of the scapula forward to 6<sup>th</sup> rib in mid-axillary line
- Trace minor fissure from 4<sup>th</sup> rib in mid-clavicular line to the mid-axillary line

## Percussion

- **History of Percussion** – Leopold Auenbrugger was the son of a hotel owner in Austria in the late 1700s. While working for his father, he learned how to use percussion to tell the level of wine in the hotel casks using a pleximeter. He later went to medical school and adapted percussion to the physical exam by filling cadaver body cavities with fluid and observing changes in sound. *“A New Discovery that Enables the Physician from the Percussion of the Human Thorax to Detect the Diseases Hidden Within the Chest”*
- **Different types of Percussion**
  - **Direct** – Using the fingertips of one hand to deliver and feel the percussion blow
  - **Indirect Percussion** – Striking a pleximeter (e.g. a finger placed against the chest wall) with a plexor (e.g. your index or middle finger of the other hand) to both hear and feel the resulting percussion note
  - **Comparative** (Auenbrugger and Laennac) – The value of percussion is in asymmetry
  - **Topographical** – belief that percussion changes are due to 4-6cm of tissue beneath the percussion stroke (later found to be incorrect)
  - **Cage resonance theory**
    - Illustrate Grocco's triangle – the area of dullness next to the spine in the side contralateral to a large pleural effusion
      - Have one of the learners press their hands firmly on the front and back of the right hemithorax
      - Demonstrate the change in percussion note on the left lower back when pressure is applied and then removed
      - This illustrates how changes in the chest wall affects vibration and debunks the topographical theory of percussion.
  - **Ausculatory** – Tapping on the anterior chest (e.g. the sternum) and listening with a stethoscope posteriorly to observe changes in the percussion note as the stethoscope is moved

*The remainder of this section will focus on indirect percussion*

- **Force of blow**
  - Some clinicians prefer a light blow so that dull areas produce no sound at all (“easier to hear something from nothing”).
  - Dull areas have been shown to move less than other areas. Some people can feel the difference in their pleximeter finger.
- **Percussion Sounds**
  - Illustrate these different notes using the healthy volunteer and/or the learners

- Tympany (stomach)
- Resonance (normal lung)
- Dullness (thigh)
- **Appropriate areas of Dullness - 5,7,9 rule**
  - 5<sup>th</sup> rib in mid-clavicular line
  - 7<sup>th</sup> rib in mid-axillary line
  - 9<sup>th</sup> rib in mid-scapular line (posteriorly)
- **Superficial Cardiac Dullness** – Compare the left anterior chest to the right
  - Lack of superficial cardiac dullness could indicate hyperinflation
- **2<sup>nd</sup> intercostal space on left**
  - Lack of resonance could indicate possible pulmonary artery enlargement
- **Traube's space** – area of tympany overlying the stomach bubble
  - Drop a perpendicular line from the:
    - 6<sup>th</sup> rib – mid clavicular line
    - 9<sup>th</sup> rib – anterior axillary line
  - Connect the lines and demonstrate the change in percussion over that area
  - If dull, suggests one of three possibilities:
    - pleural effusion that has tracked around to the front
    - splenomegaly
    - full stomach

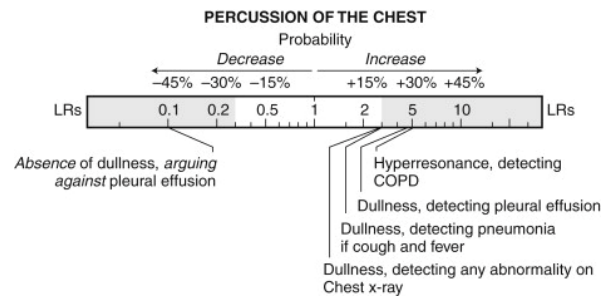


Figure 3. From McGee's Evidence-Based Physical Diagnosis, Chapter 27

## Fremitus

The lung is a low pass filter that allows sounds from around 100-200Hz to reach the chest wall. Men usually have more fremitus than women because of lower pitched voice. The key to fremitus is not whether a person has detectable fremitus, but whether there is asymmetry in fremitus that suggests a change in the filtering property of the lung in that area.

Have the volunteer sing "Lalalalalala" in an ascending scale from low to high. Fremitus will decrease as the frequency gets higher.

### ➤ Changes in fremitus/auscultation

- **Bronchophony** ~300Hz
- **Whispered pectoriloquy** - ~400Hz
- **Consolidation** – Allows all sounds through so you can have increased fremitus, and bronchophony

- **Pleural effusion** – A pleural effusion usually leads to reduced fremitus as it decreases transmission of lower frequency sounds. A large pleural effusion causes compressive atelectasis so there can be areas of increased fremitus, particularly in areas where the compressed lung is close to the chest wall. *As a result, an effusion can have areas of both increased and decreased fremitus!*
- **Demonstrating fremitus using plastic cups<sup>5</sup>**
- You will need 2 rigid plastic cups (I use cups from Royal Farms™ slushies) and a straw*
- To demonstrate normal fremitus, place the straw inside one cup and hum into the straw while learners touch the outside of the cup with their fingertips. They should feel vibrations.
  - To demonstrate increased fremitus from a consolidation, fill the cup with water and repeat the steps above. Vibrations should be increased.
  - To demonstrate decreased fremitus from a pneumothorax, place one cup inside the other. Place the straw inside the inner cup and hum into the straw while learners touch the outside of the outer cup with the fingertips. Vibrations should be reduced because of the additional air between their fingertips and the vibrating inner cup.
  - To demonstrate decreased fremitus from a pleural effusion, fill the outer cup with water and repeat the steps above. Vibrations should be reduced because of the additional water between their fingertips and the vibrating inner cup.

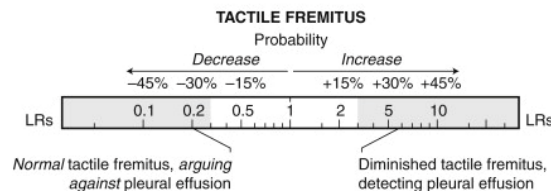


Figure 4. From McGee's Evidence-Based Physical Diagnosis, Chapter 27

<sup>5</sup> Inspired by Sandra G. Adams, Tactile Fremitus: Cups Demonstration on Youtube. <https://youtu.be/uzgdaJcF0Mk>