

Examination of the Cardiopulmonary System

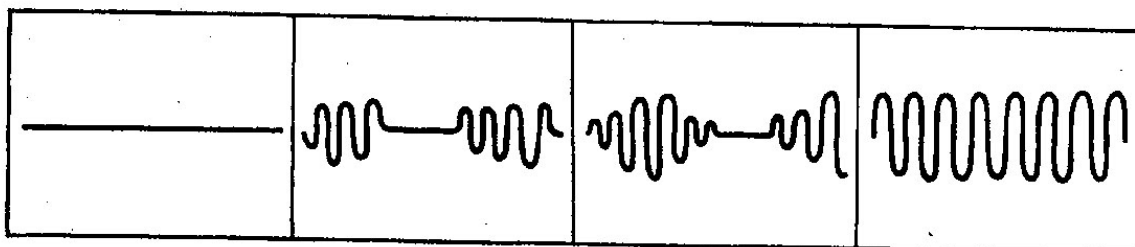
Mary Beth Fontana MD & Nitin Bhatt MD

Objectives:

- Describe the gross anatomy of the heart chambers, valves, and great vessels as well as relationships to each other and to chest wall landmarks
- Observe and accurately describe respiratory pattern (including respiratory rate) and work of breathing
- Palpate extremity pulses and listen for bruits
- Evaluate carotid pulse and auscultate for bruits
- Determine blood pressure (both arms) and pulse rate and regularity
- Identify jugular venous pulse components and assess jugular venous pressure
- Localize and characterize the apex impulse
- Auscultate the 4 basic auscultatory areas with bell and diaphragm of stethoscope
- Auscultate in supine, left lateral, sitting, standing and squatting positions
- Describe how respiratory and positional maneuvers can enhance cardiac diagnosis
- Demonstrate the technique of chest auscultation
- Distinguish between normal and abnormal (wheeze, rhonchi, stridor, rales) breath sounds
- Demonstrate inspection, palpation, and percussion of the chest
- Demonstrate appropriate inspection of the upper airway structures (nasal, oropharyngeal, cervical)
- Describe findings suggestive of underlying chest disorders (pleural fluid, pneumonia, pneumothorax)

General:

- Positioning the patient
 - Undressed to the waist, sitting at the side of the bed
- Watch for signs of dyspnea at rest. Is the patient in respiratory distress?
 - Count the respiratory rate (should be around 12-14/min)
 - Position (supine, upright, tripod)
 - Orthopnea: increasing dyspnea lying down
 - Platypnea: increasing dyspnea sitting up
 - Oxygen saturation (Pulse oximetry, SpO₂)
 - Orthodeoxia: decreased oxygen saturations sitting up
 - Use of accessory muscles of respiration, breathing through pursed lips (emphysema)
 - Ability to speak? A complete sentence, fewer words, nods Y/N?
- Is there any specific pattern of respiration?
 - Tachypnea? Bradypnea?



APNEA

BIOT'S

CHEYNE-STOKES

KUSSMAUL

- Cheyne stokes pattern (periodic breathing)
 - Hyperventilation intermittent with periods of apnea. Seen mainly in brain injury, CHF, and at high altitude.
- Kussmaul breathing
 - Deep rapid respirations, seen in metabolic acidosis.
- Paradoxical respirations (abdominal paradox)
 - Paradoxical inward motion of the abdomen as the rib cage expands outwards during inspiration.
- Is the pt cyanotic?
 - Central cyanosis (tongue), peripheral cyanosis (lips, hands, nailbeds)
 - Blueish discoloration of the skin or extremities due to increased deoxygenated hemoglobin in the blood
 - Causes:
 - Central cyanosis:
 - Decreased arterial O₂ saturation: Decreased O₂, lung disease, R to L intracardiac shunt
 - Hgb abnormalities
 - MetHgb
 - Hgb-Fe³⁺ instead of Hgb-Fe²⁺, reduced Hgb oxygen saturation
 - Acquired (medications: lidocaine NTG, sulfa)
 - Chocolate colored blood
 - Peripheral cyanosis:
 - All causes of central cyanosis
 - Cold, reduced cardiac output, arterial or venous obstruction
- Examine the extremities
 - Hands for clubbing

<p>A Appearance Normal: Shows a normal nail bed with a clear demarcation between the nail and the skin. Clubbed: Shows a bulbous, swollen tip of the finger with a loss of the normal demarcation.</p> <p>B Nail-fold Angles Normal: Shows the angle between the nail and the skin fold (A-B-C-D) is acute. Clubbed: Shows the angle between the nail and the skin fold (A-B-C-D) is obtuse.</p> <p>C Phalangeal Depth Ratio Normal: Shows the ratio of the proximal phalanx (DPD) to the distal phalanx (IPD) is normal. Clubbed: Shows the ratio of the proximal phalanx (DPD) to the distal phalanx (IPD) is increased.</p> <p>D Schamroth Sign Normal: Shows two fingers held together with a normal diamond-shaped gap between the nail beds. Clubbed: Shows two fingers held together with a loss of the diamond-shaped gap.</p>	<p>Table 2 Common Causes of Finger Clubbing Subdivided According to the System with the Underlying Disorder</p> <table border="1"> <thead> <tr> <th>System</th> <th>Potential Causes</th> </tr> </thead> <tbody> <tr> <td>Respiratory</td> <td>Lung fibrosis Suppurative lung disease: Bronchiectasis Lung abscess Empyema Pulmonary tuberculosis Lung cancer (rarely small cell) Mesothelioma Pulmonary arteriovenous malformation Thymoma</td> </tr> <tr> <td>Cardiovascular</td> <td>Subacute bacterial endocarditis Left atrial myxoma Cyanotic congenital heart disease Thoracic aortic aneurysm</td> </tr> <tr> <td>Gastrointestinal</td> <td>Malabsorption, celiac disease Inflammatory bowel disease: Crohn's disease and ulcerative colitis Hepatic cirrhosis, especially primary biliary cirrhosis</td> </tr> <tr> <td>Other</td> <td>Esophageal cancer Thyroid acropachy (mimics clubbing in patients with Graves' disease) Genetic Trauma (may be unilateral or spare some nails) Thalassemia</td> </tr> </tbody> </table>	System	Potential Causes	Respiratory	Lung fibrosis Suppurative lung disease: Bronchiectasis Lung abscess Empyema Pulmonary tuberculosis Lung cancer (rarely small cell) Mesothelioma Pulmonary arteriovenous malformation Thymoma	Cardiovascular	Subacute bacterial endocarditis Left atrial myxoma Cyanotic congenital heart disease Thoracic aortic aneurysm	Gastrointestinal	Malabsorption, celiac disease Inflammatory bowel disease: Crohn's disease and ulcerative colitis Hepatic cirrhosis, especially primary biliary cirrhosis	Other	Esophageal cancer Thyroid acropachy (mimics clubbing in patients with Graves' disease) Genetic Trauma (may be unilateral or spare some nails) Thalassemia
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Cyanosis & Clubbing CHD



- Cyanosis detectable at about 88% O₂ saturation in natural light
 - Nicotine staining
 - Evidence of arthritis or autoimmune disease (rheumatoid arthritis, lupus, scleroderma)
 - Examine the pulse
- Examine for flapping tremor: dorsiflex the wrists with outreached arms and spread out the fingers. Often seen in cirrhosis.
- Does the patient have hoarseness
 - May be caused by laryngitis, upper airway
 - Involvement of the recurrent laryngeal nerve from CA (mediastinal on left) or injury.
- Does the patient have stridor
- Examine the eyes for evidence of Horner's syndrome
- Involvement of the sympathetic nerve supply to the eye with triad of miosis (constricted pupil), partial ptosis, and loss of hemifacial sweating (anhidrosis)
 - Apical lung cancer.
- Examine the nose for polyps (asthma), engorged turbinates (allergies), and deviated septum.
- Examine the mouth for central cyanosis.
- Examine the teeth as may be a risk factor for aspiration pneumonia.

Blood Pressure and Pulses

- Take in both arms
- Take in leg -- can use arm cuff around calf and palpate foot pulse
- Take by palpation to confirm systolic pressure
- Take pulse by precordial auscultation if slow or irregular when checking radial pulse

Peripheral pulses

- No intervening clothing!!!!
- Extend elbow and supinate hand for brachial
- If no radial, feel for ulnar

- When listening for bruits, don't press hard and make one
- Check brachial and femoral pulses simultaneously, should be no delay
- Don't use any peripheral pulse to time cardiac events-- use apex or carotid

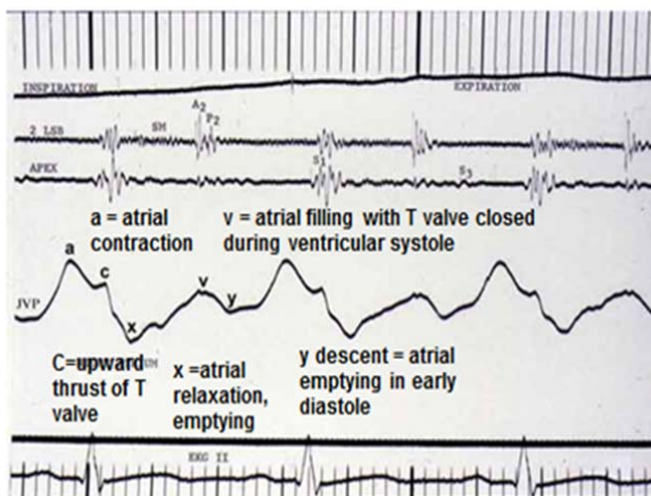
Carotid pulse

- Palpate at level of thyroid cartilage; not the angle of the jaw
- Magnitude, upstrokes, number of peaks, thrills, stiffness of wall, bruits
- Carotid bruit-- if maximum at bifurcation-primary carotid cause
- If loudest at base of neck- likely transmitted from heart
- When auscultating carotid, suspend respirations, turn off oxygen or kink line briefly. Supine position best as stroke volume is higher
- Don't forget to palpate the suprasternal notch for slow upstrokes, thrills, bruits in aortic stenosis (AS)

Jugular venous pulse

- Oblique illumination with head up 10-15 degrees or higher
- Normal JVP should not be visible at 45 degrees
- Use internal jugular: external jugular may not show true waves or pressure

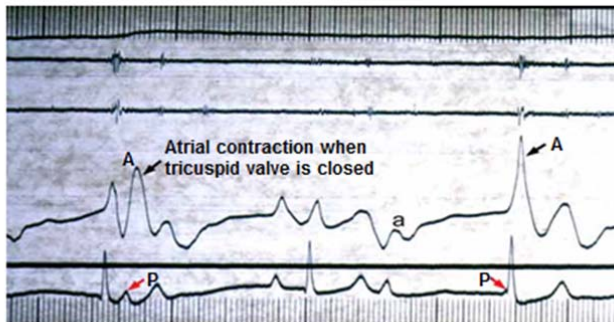
Normal JVP - RA



- Descents are easier to see than rise of waves
- Use opposite carotid to time waves--"a" before and "v" after the carotid
- Can diagnose atrial fibrillation. by lack of "a"; atrial flutter waves can sometimes be visible
- Cannon "a" waves can help to diagnose PVC's and dissociation of atrial and ventricular depolarizations as in ventricular tachycardia and complete heart block

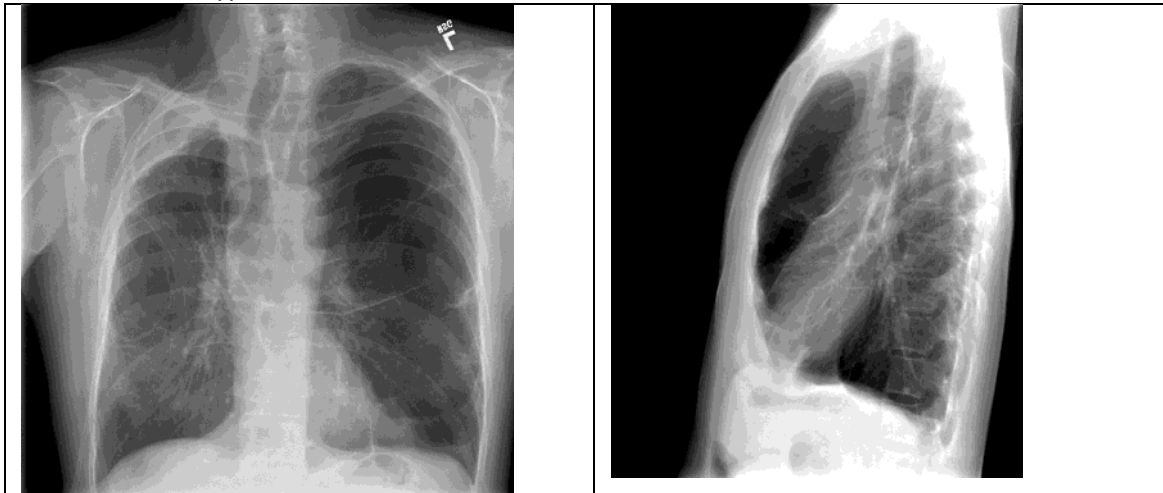
AV Dissociation – Cannon A waves

P waves and QRS's occur independently due to complete block of conduction at the AV node



Examine the chest: Inspection

- **Shape and symmetry of the chest :**
 - Barrel chest: increased AP diameter compared to lateral diameter. Seen in hyperinflation with COPD.



- Pigeon chest (pectus carinatum): Protrusion of the sternum and costal cartilages.
- Funnel chest (pectus excavatum): Depression of the lower end of the sternum.
- Kyphosis and kyphoscoliosis
- Abnormal skeletal features above can be signs of connective tissue diseases with cardiac manifestations—Marfan Syndrome



- Lesions of the chest wall:
 - Scars, especially those from previous cardiac surgery
 - Abnormal skin
 - Subcutaneous emphysema: Better felt (crepitus) than seen. Seen in pneumothorax, ARDS.
 - Prominent veins with no pulsations: SVC syndrome
 - Tender point, rib fractures, masses
- Movement of the chest wall: Amount of expansion and asymmetry of expansion

Palpation -Respiratory:

- Chest expansion
 - Place hands posteriorly, low (~10th rib) and take deep breath
 - Symmetry
 - 2-3cm normal expansion
- Examine the trachea:
 - Location, usually midline
 - Shifted towards lung fibrosis, collapse, and after pneumonectomy
 - Shifted away from pleural effusion, pneumothorax, and masses
 - Feel for a tracheal tug: inferior movement of the trachea with inspiration
- Palpation of the apical beat
 - May be difficult to palpate in severe hyperinflation. Displaced inferiorly
- Vocal (tactile) fremitus:
 - Palpate using the ball of your hand or palms to compare localized areas in both lungs.
 - Ask the patient to say "99" several times in a normal voice.
 - Feel the vibrations transmitted through the airways to the lung, information about the density of underlying lung tissue and chest cavity.
 - Decreased or absent when sound transmission impeded (obstructed bronchus, COPD, pleural fluid, or thick chest wall).
 - Increased when transmission of sound increased (consolidated lobar pneumonia).

Palpation – Cardiac

- Apex Impulse
 - Should be at or inside midclavicular line in 5th ICS supine or sitting
 - Left lateral decubitus position if not palpable supine or sitting; cannot use landmarks for size
 - Size, duration, thrills, double or triple impulse should be assessed
 - Apex should be no larger than a quarter
 - Use percussion if not palpable
 - Heart sounds may be palpable if loud, especially mechanical prostheses
 - Don't forget the parasternal area for a right ventricular heave, thrill
 - Check the epigastrium in patients with chronic obstructive pulmonary disease (COPD)

Percussion:

- Percuss in similar areas both lungs between the ribs
- Can percuss the supraclavicular spaces, axilla
- When percussing posterior move the scapula out of the way by asking the patient to move the elbows across the front of the chest.
- Produces
 - Low-pitched, resonant note of high amplitude over normal lungs.
 - Dull, short note whenever fluid or solid tissue replaces air filled lung (pneumonia, mass, diaphragm) or when fluid in the pleural space (pleural effusion).
 - Hyperresonant note over hyperinflated lungs (COPD).
 - Tympanic note over no lung tissue (pneumothorax).
- Percuss for the hemidiaphragm positions
 - Patient sitting upright, percuss the inferior portions of the lung for dullness.
 - Compare the two sides. Normally are equal or the right side is slightly higher by 1-2 cm. Abnormal if the left diaphragm is higher.
 - Should both decrease several cm with inspiration. If no change, consider paralyzed hemidiaphragm
- Percuss for liver dullness: may be displaced from hyperinflation



Auscultation - Cardiac

- **Quiet environment!!!!**- listen again if noisy environment initially.
- Be systematic, listen to all auscultatory areas with bell and diaphragm
- Best discriminator of auscultatory skills-- can you hear normal splitting of S2. It is only 40-60msec!!!!
- OK to suspend respirations briefly to hear splitting
- P2 normally only heard in the pulmonic area
- Split S1 - ejection click - S4 gallop - early nonejection click- a tough differential
 - Split S1 constant with position, common in young
 - Ejection click constant with position if aortic in origin; interpret with other findings
 - Pulmonic valve click louder with **expiration**
 - S4 gallop-- low pitched, with bell, left lateral, not heard upright
 - Non ejection click-- MVP, move toward S1 standing, later squatting
- Continuous murmurs loudest where abnormal flow empties
- Ejection murmurs augment after long R-R intervals, regurgitant murmurs constant
- Posterior leaflet mitral valve prolapse (MVP) mitral regurgitation murmur can radiate to aortic area
- Calcific aortic valves make snoring murmurs
- If systolic murmur in elderly, if you hear normal splitting of S2 in the pulmonary area, it's not severe AS

Maneuvers enhance diagnostic skill

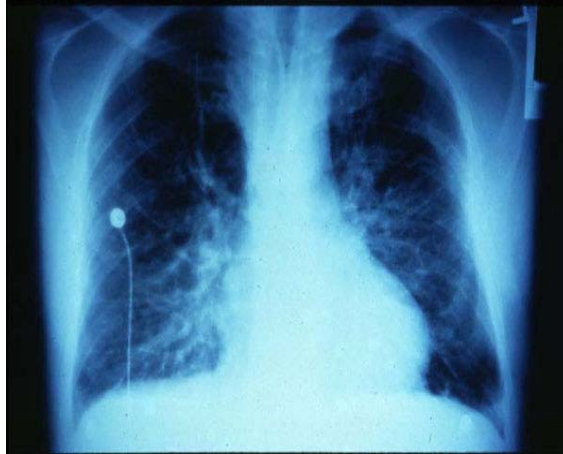
- 5 auscultatory positions- supine, left lateral, sitting, standing, and squatting
- You squat with patient and listen as patient stands from squat
- Patient must squat promptly (you can sit in a chair), should get reflex bradycardia
- Only 2 murmurs that decrease with squatting are MVP, hypertrophic obstructive cardiomyopathy (HOCM)
- MVP clicks, murmur earlier, often louder standing
- Aortic regurgitation murmur accentuated by squatting
- A systolic ejection murmur that disappears upright is innocent, save \$ on echocardiogram
- Can use Valsalva maneuver if the patient can't squat
 - Straining phase like upright position, release like squatting
- Inspiration increases right heart findings **except** ejection click of PS, which decreases
- Raise legs increases venous return, right heart events augment immediately
- Handgrip increases resistance-- MR murmurs accentuate, HOCM diminishes

Auscultation: Breath sounds:

- Have the patient sit upright if possible, breathing slowly and deeply through the mouth.
- Use the diaphragm of the stethoscope, placed directly on the skin.
- Auscultate all areas systematically including anterior, posterior, and lateral lung fields.

- Compare sounds heard on one side to the same location on the opposite side. Compare the apices to the bases.
- Listen to inspiration and expiration in each location.
- Note the inspiratory to expiratory ratio.
- Lung sounds may be louder in areas where lung tissue is denser.
- Lung sounds may be diminished due to shallow breathing or hyperinflation, pleural disease, mucous plugging or obesity.
- Lung sounds are absent over a pneumothorax.
- Vesicular breath sounds
 - Normally are heard all over the chest. Usually louder and longer in inspiration with no gap between inspiration and expiration.
- Bronchial sounds
 - Hollow blowing sounds. Generated from the airways, normal over manubrium. Equal inspiration and expiration. Gap between inspiration and expiration.
 - Abnormal if heard away from large airways.
 - Usually is a sign of consolidation but may be heard over a pleural effusion or a collapsed lung. Solid material inside the alveoli transmits sound directly to the larger airways.
 - Intensity: increased, decreased
- Adventitious breath sounds
 - Describe the timing in the respiratory cycle (late inspiratory crackles or inspiratory and expiratory wheezes), location, and if the sounds clear with cough.
 - Wheezes:
 - Starts on expiration but if present on inspiration it signifies severe obstruction.
 - May be absent in severe obstruction.
 - Localized wheezed suggests a localized obstruction caused by compression, mass.
 - Stridor is an inspiratory wheeze generally associated with upper airway obstruction.
 - Crackles (rales):
 - Secondary to small airways which collapses on expiration.
 - Early inspiratory crackles may suggest disease of the smaller airways (COPD).
 - Late inspiratory crackles suggest disease of the alveoli. May be fine, moist crackles seen in pulmonary edema (“rice krispies”) or harsh (“velcro”) seen in pulmonary fibrosis.

Heart Failure- Pulmonary Edema



- Rhonchi:
 - Snoring or gurgling quality, can be heard in inspiration and expiration, may improve with cough
- Squeaks:
 - Short, inspiratory wheeze due to closed airway suddenly opens in inspiration for a brief moment
- Pleural friction rub:
 - Caused by inflamed pleural surfaces, pleurisy.
- Egophony:
 - Ask the patient to say "ee" several times.
 - Auscultate several symmetrical areas over each lung.
 - Normally hear a muffled "ee" sound. If you hear an "ay" sound this is referred to as "E -> A changes" or egophony.
 - Sign for consolidation.
- Whispered pectoriloquy (chest speaking) or vocal fremitus:
 - Ask the patient to whisper "ninety-nine" several times. Auscultate several symmetrical areas over each lung.
 - You should hear only faint sounds or nothing at all. If you hear the sounds more clearly this is referred to as whispered pectoriloquy. Indicates consolidation.

Correlation of respiratory signs with disease:

Disorder	Displacement	Movement	Percussion	Sounds	Extra	Vocal resonance
Consolidation	None	↓ affected area	Dull	Bronchial	Crackles	↑
Collapse	Shift towards	↓ affected area	Dull	Absent or reduced		Absent
Effusion	Away	↓ affected area	Stony dull	Absent over fluid, bronchial above	Rub , crackles above	↓
Pneumo	Away	↓ affected area	Resonant	↓	None	↓
Pulm fibrosis	None	↓ Symmetrically	Normal	Normal	Late insp crackles	Normal

Whether you are inspecting, palpating, percussing, or ausculting--- think of the relationships of electrical, mechanical, and acoustical events responsible for all findings, normal or abnormal. During the pulmonary examination, think of the physiologic and pathophysiologic causes for your findings. You will become a brilliant diagnostician and use tests to confirm and quantitate diagnoses you've already made

References.

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