S9 - Respiratory Illness Detection in Different Imaging Modalities

Objectives:

- Define common respiratory illnesses diagnosed through medical imaging.
- Present how CT imaging is the most common and effective tool to image and diagnose respiratory illnesses.

Thesis Statement:

Explain prevalent respiratory illnesses and show what imaging modalities are necessary for detection.

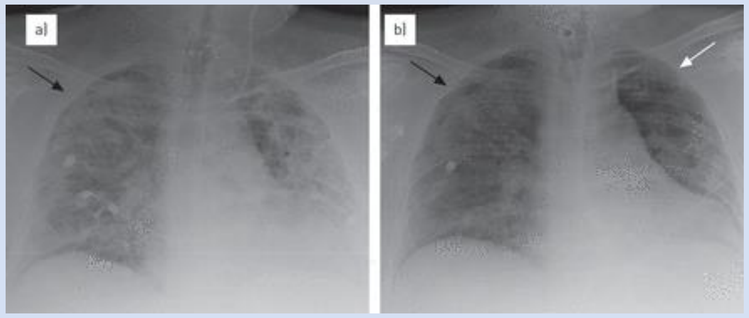
Common Respiratory Illnesses:

- COVID-19 is a disease caused by a rapidly spreading virus known as SARS-CoV-2 (Centers for Disease Control and Prevention, 2024).
- The Mayo Clinic defines Pneumonia as an infection that inflames the air sacs in one or both lungs (Mayo Clinic, 2024).
- Cystic Fibrosis is an inherited condition that damages the lungs and the digestive system (Mayo Clinic, 2023). Cystic Fibrosis is a result of inherited mutations in the CFTR gene (Mayo Clinic, 2023).
- Acute Respiratory Distress Syndrome (ARDS) is characterized by swelling of the lungs due to a buildup of fluid in the alveoli (Mayo Clinic, 2023).

Common Symptoms:

- COVID-19 is very similar to Influenza, a cold, and Pneumonia. Fevers, chills, cough, sore throat, and fatigue are all common with this disease.
- Pneumonia causes similar symptoms to COVID-19, including fever, chills, and difficulty breathing (Mayo Clinic, 2024).
- Cystic Fibrosis usually presents through a persistent cough, wheezing, lung infections, and even digestive issues (Mayo Clinic, 2024).
- ARDS can appear as rapid shallow breathing, confusion, chest pain, coughing, and a fast heart rate. Patients may develop fibrotic tendencies after surviving ARDS, and it is commonly regarded as the most dangerous respiratory illness.

ARDS Chest Radiograph Evaulation



Zompatori, M. (2014). *Overview of Current Lung Imaging in Acute Respiratory Disease.*

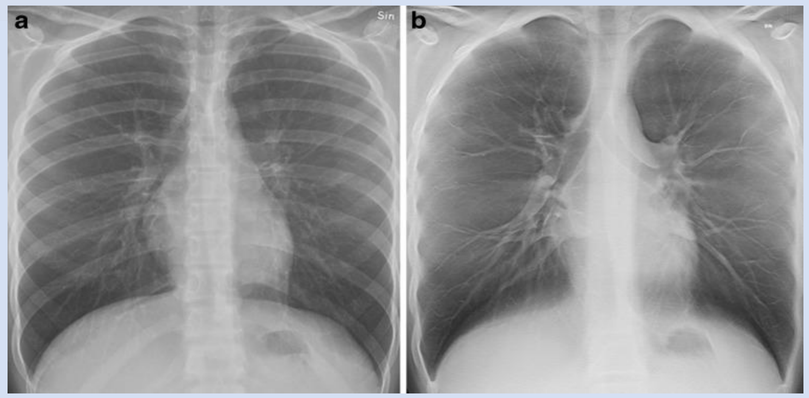
ARDS is similar to COVID-19 in appearance in radiographs because it is an evolution of the COVID-19 virus. Imaging for ARDS evaluates possible opacities and infiltration of fluids in lung alveoli (Zompartori, 2014). The white and black arrows in the image above show the locations of pneumothoraces in the chest image. Much can be visualized in a two-view chest X-ray, but CT typically allows more detail to be shown.

- The three modalities most commonly used for diagnosing ARDS are radiographs, CT scans, and ultrasounds.

How CT is Used to Diagnose:

- The common standard for evaluating COVID-19 is Computed Tomography. When imaging for Covid-19, it is essential to complete the CT in the early stages. The longer a respiratory illness goes untreated, the worse the disease gets. The CT allows radiologist can see the ground-glass opacities, lung lesions, and mucous thickening in the lungs (Simpson, 2020).
- CT is also the most commonly used modality for Cystic Fibrosis. Bronchiectasis, peribronchial thickening and mucus plugging are the most frequent abnormalities that can be seen in CT (Rybacka, 2016).
- Pneumonia is that illustrated in a CT shows the lungs having white areas, or opacities, that are lobar or segmental, or simply patchy opacities (Gemzell, ND).
- Diagnosing ARDS also primarily utilizes CT. In earlier phases, asymmetrical opacities and ground-glass opacifications seen on CT can help diagnose. In later phases, pulmonary cysts of varying sizes may be present (Zompatori, 2014).

Tomography in Cystic Fibrosis



Ooi, G., et al. (2011). *Radiograph vs. Tomograph Lung Scan*

Image A depicts a typical chest radiograph, while image B shows a tomographic image of the lung field. Image B shows how tomographic imaging can present the lungs free of view obstruction from the ribs. Tomographic images are obtained by the patient lying on a table while the X-ray tube rotates around the body, taking images at multiple locations (Radiol, 2013). Tomography takes more time than a typical one-view X-ray, which can result in more patient motion (Ooi, 2011). This different imaging can be beneficial, though, when trying to visualize soft tissue more clearly.

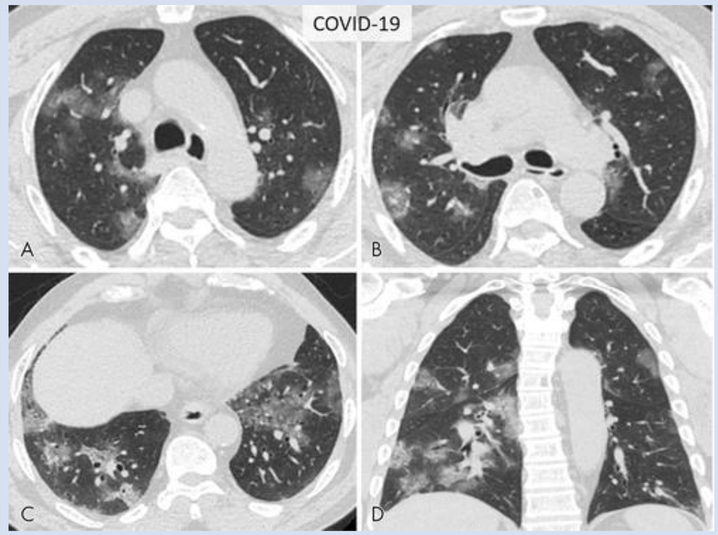
Other Imaging Modalities Used:

- Although a CT is the most commonly ordered exam for diagnosing COVID-19, other modalities can be utilized to provide different clinical indications. Radiography, MRI, and PET scans can provide varying degrees of information for diagnosis (Soni, 2022).
- The most common modality used for Pneumonia is a radiograph (Mayo Clinic, 2023). The radiograph is used to localize and determine the severity of the infection upon admission (Mayo Clinic, 2023).
- Cystic fibrosis also uses other unique radiographic studies like Tomosynthesis and Dynamic Radiographic studies (Ooi, 2011). Also in regard to picture quality, Tomography presents typical pulmonary changes in mucus, bronchial wall thickening, and bronchiectasis with much better clarity than CT (Ooi, 2011).
- When diagnosing ARDS, radiographic findings are usually non-specific and similar to pulmonary edema or pulmonary hemorrhages. Bilateral opacities are also commonly seen. CT offers different clinical indications dependent on which phase of disease the patient is in. Utilization of Ultrasound can display thickening and/or irregularity of visceral-parietal pleural interface and presence of pneumothorax (Zompatori, 2014).

Artificial Intelligence in Detection:

The increasing reliance on imaging to determine the presence of Respiratory Illnesses has led to work overload for Radiologists. The evolution of Artificial Intelligence in the medical field has helped address the growing overflow of images. The biggest advantage of AI in image evaluation is speed (Alnuaimi, 2022). With imaging reading software, it can highlight areas that the radiologist should focus on. Many studies have compared highly trained radiologists to AI image programs, and AI has surpassed all expectations. AI not only detected pathology, but it also predicted the mortality rate of the patient (Alnuaimi, 2022). Just as a human Radiologist would read the image, the AI looks for the same opacities and lesions while measuring the volume of the mass (Alnuaimi, 2022). When used correctly, AI can be a useful tool in detecting respiratory illness pathologies and aid in workflow for radiologists.

CT of Chest with Contrast



Soni, N., et al. (2022) *Imaging of Covid-19 Pneumonia*

The image above is a contrast CT scan from a case study involving a 58-year-old man with COVID-19. This study helped reveal a mass that would have otherwise gone undetected without contrast (Soni, 2022). The mass can be seen in the lower right lung on the images. Radiologists determined the mass was consistent with cavitation. Cavitation can be described as the formation of an empty space within a solid object or body (Soni, 2022). This is not typical for a patient with COVID-19.

Conclusion:

- Medical imaging is a crucial step in diagnosing respiratory illnesses. It provides a visual capability that aids in classifying diseases and encouraging proper treatment.
- Tomography, X-ray, MRI, and PET scans are used to aid in diagnosing respiratory illnesses but less than CT.
- CT is the dominant tool used to diagnose a variety of respiratory illnesses and is used across many prevalent diseases impacting the lungs.