The Role of Low Dose CT in Diagnosing Lung Cancer

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Did You Know…

- Lung cancer is:
  - The most diagnosed malignancy
  - Leading cause of cancer death worldwide
- Estimated 2,093,876 new cases in 2018, 1,761,007 resulted in death (Edelman et al., 2020, p. 1140)
- Poor prognosis with a 5-year survival rate of 16% (Sadate et al., 2020, p. 108)
- When detected in asymptomatic patients, most cases can be treated with an overall survival rate of 92% (Edelman et al., 2020, p. 1140)

What is Computed Tomography (CT)?

- Imaging modality technique that produces cross-sectional images from x-rays.
- Images obtained are reconstructed through attenuation coefficients that create multiple views in the coronal, sagittal and axial planes (DeMaio, 2019, p. 87)
- Able to detect more cancers at earlier stages (Sadate et al., 2020, p. 108)

Image 1. Displays a basic CT Unit. (Waygate Technologies n.d., [Picture])

- Low-Dose CT lung screening caused a 20% reduction of mortality from lung cancer compared to chest x-ray screening (Edelman et al., 2020, p. 1140)

Low-Dose Lung Cancer Screening (LDCT)

- Process to detect lung cancer in its early stages when more likely to be cured
- Ideal Population: current or former smokers ages 50 and older with a history of smoking for 20 pack years or longer, patients with a history of lung cancer, and patients with other respiratory disorders such as chronic obstructive pulmonary disease (COPD)
- How to calculate "Pack Years"
  - Multiply number of packs of cigarettes smoked daily and number of years smoked
- Most medical professionals recommend annual lung cancer screenings until one is unlikely to benefit from screening (Mayo Foundation for Medical Education and Research, 2022, para. 4-7)

Comparison to Standard CT

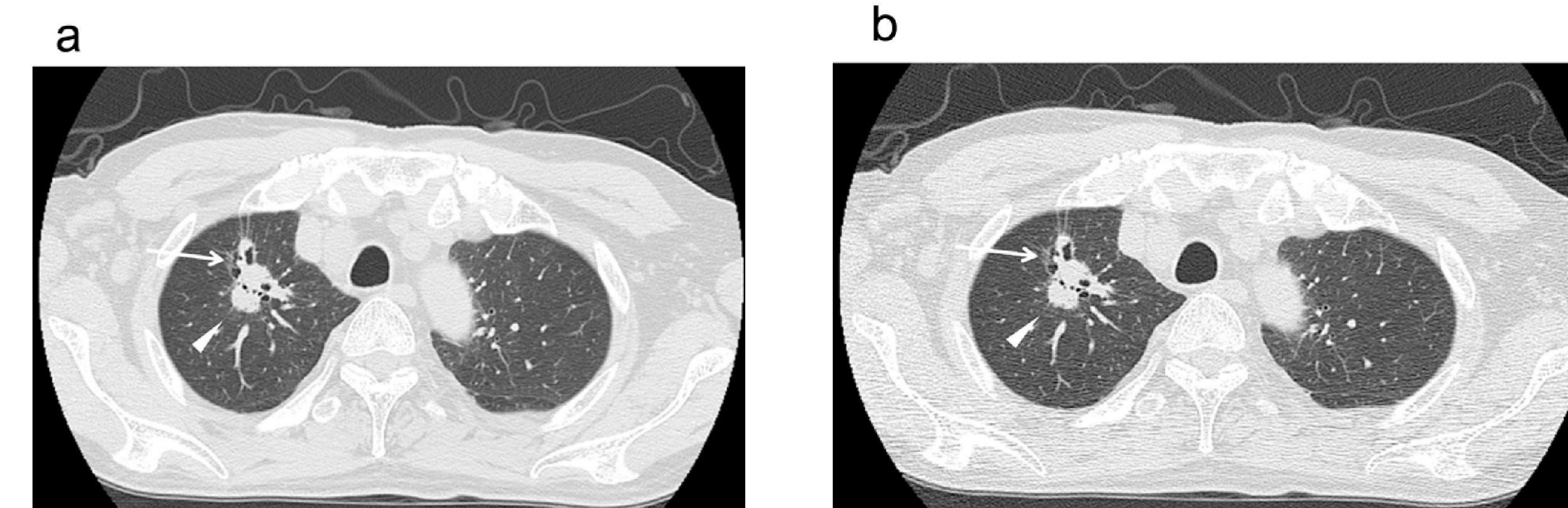| Standard	LDCT
- Single Source	- Multi-source
- 6.1 mSv approx. effective dose	- 1.5 mSv approx. Effective dose

(American College of Radiology, 2022, [Chart])

Image 2. Comparison between standard and LDCT. A represents standard and B represents low-dose. Both images appear to be nearly identical showing the efficiency of LDCT (Kubo et al., 2016, p. 68)

- Ultra-low dose computed tomography (ULDCT) reduces doses to sub-millisievert (Vonder, Dorrius, & Vliegenthart, 2021, para. 8)

Dose Reduction Techniques

- **Dual Source**: two separate x-ray tubes and detector arrays 90 degrees from each other (DeMaio 2019, p. 211)
- **Dual Energy**: the use of two separate x-ray photon spectra to allow the integration of materials that have different attenuation properties (Murphy, 2023, para.1)
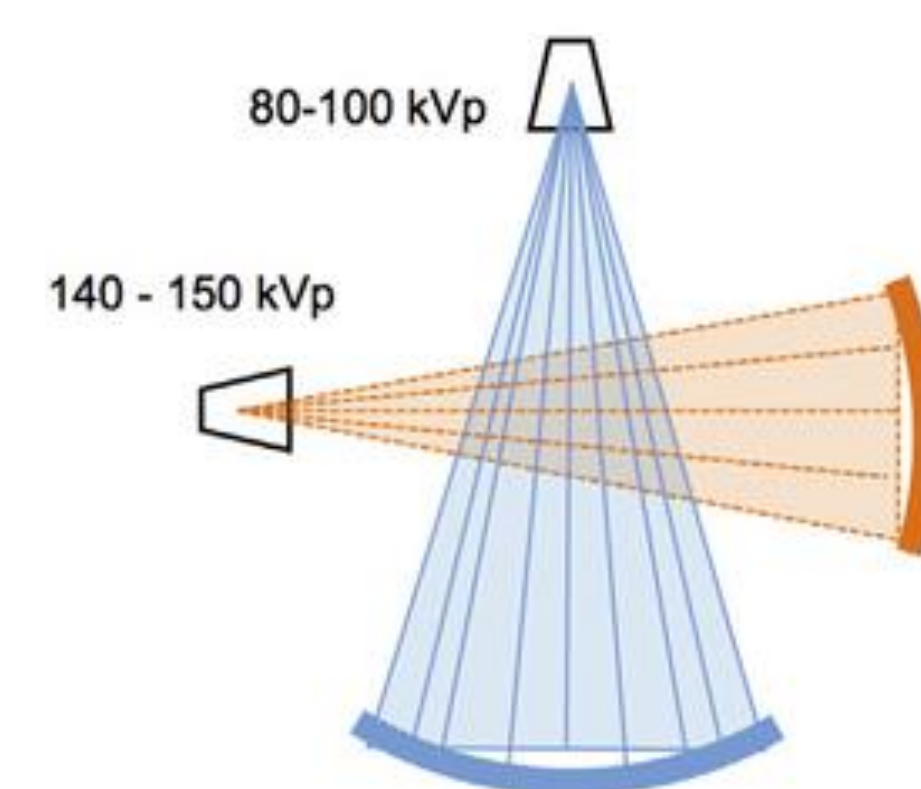

Image 3. Displays a scanner's ability to produce kVp at two different intensities (Grajo, 2017, para. 2)

- **Iterative Reconstruction**: mathematical algorithim for reconstruction to reduce image noise and reduction in technical factors
  - **Adaptive:** standard algorithim in addition to comparisons between measured pixel and those from an ideal set to create new pixel values
  - **Model-based:** considers the shape of the beam pre-patient and post-patient, uses statistical analyses both in a forward-backward series of reconstructions (DeMaio, 2019, p. 105)

Procedure

- Each item of clothing leading to image artifacts must be removed. These include metal zippers, buttons, necklaces, underwire, thick logos, etc.
- Patient is positioned supine with head on a pillow & feet directed toward the tube. A cushion may be provided under the patient's knees for comfort & arms over head
- The patient is centered to the top of the lung apicies and mid-sagittal plane (MSP)
- A specific low-dose protocol is selected for the scan and images are taken upon inspiration
- Once the procedure is complete, the patient may resume normal day to day duties

Case Study

- 84,558 participants with an average smoking history greater than 15 pack-years
- Findings:
  - Screening group showed 17% reduction in lung cancer specific morality
  - Better at detecting individuals in the high-risk subgroup than those in a low-risk group
    - Suggests that prime candidates may be restricted to patients with the highest risk (Sadate et al., 2020, p. 107)

Risk vs. Benefit

Risk:

- Radiation induced cancers
- False-positives results leading to additional testing or invasive procedures
  - For every 1000 persons screened, there is an estimated 17 false-positive results that led to invasive procedures
  - Can lead to more radiation and invasive tests, exposing a patient to potential risks that could be avoided by not screening
- Overdiagnosis
  - Detection of a cancer that may never cause harm to the patient
- Incidental Findings
  - Other health problems detected may lead to further testing and invasive treatments
- Increases in stress (Jonas et al., 2021, p. 971)

Benefits:

- Only receive about half of the radiation one gets throughout an entire year
- Detect lung cancer at earlier, more treatable stages

(Mayo Foundation for Medical Education and Research, 2022, para. 16)

Barriers to Access

Provider
- Unfamiliar with LCS guidelines
- Limited opportunity for shared decision-making visits

Patient
- Lack of awareness
- Cost concerns
- Limited access due to transportation issues
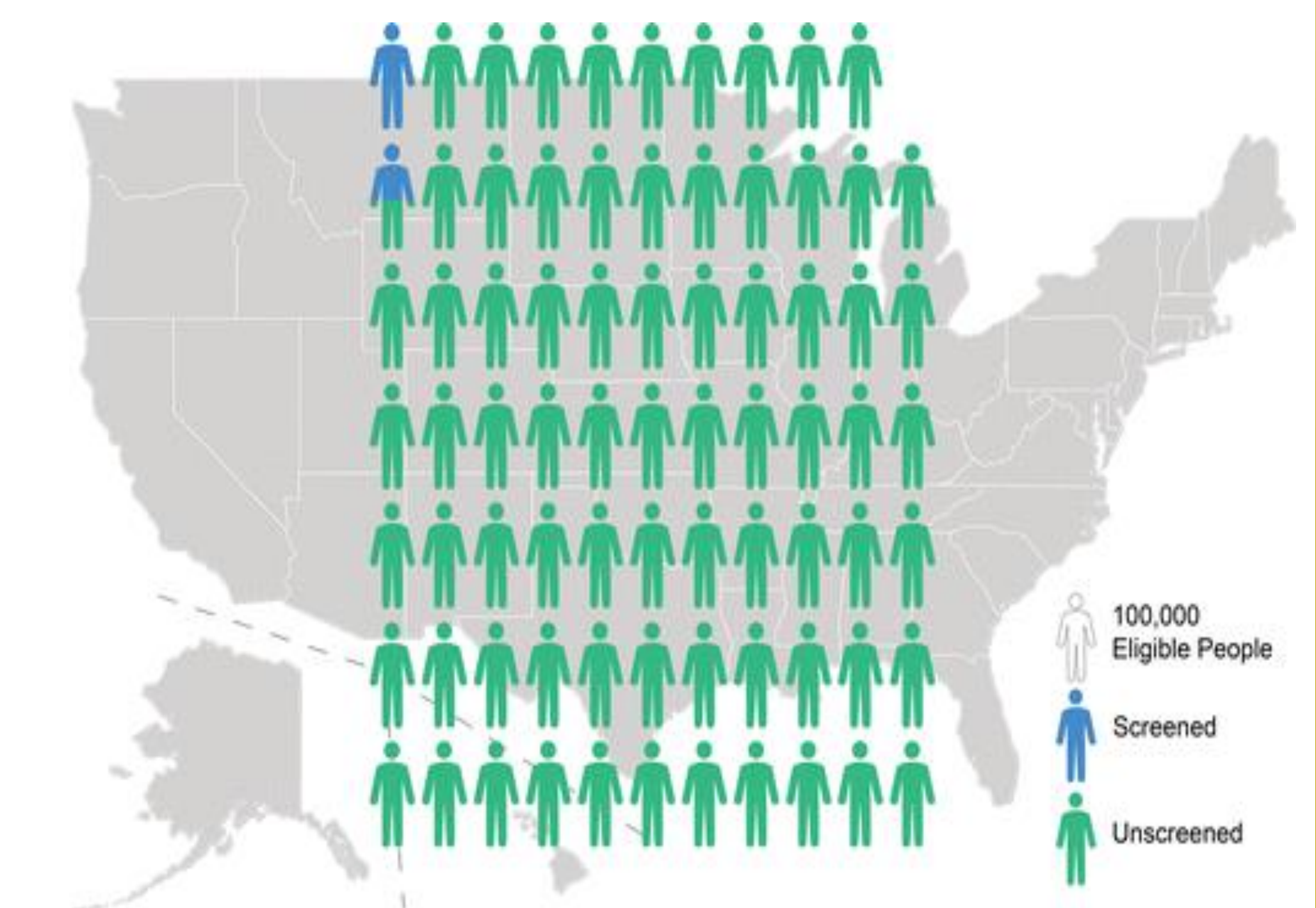
(Wang et al., 2019, pp. 281-282)

Image 4. "Lung cancer screening rate in the United States in 2016. A 2018 analysis reported that of an estimated 7.6 million eligible smokers, 141,260 underwent screening in 2016" (Wang et al., 2019, p. 208)

Conclusion

- The cancer that causes the most fatal diagnoses in the US continues to be lung cancer. Those who have a high risk of developing lung cancer can undergo a routine annual scan called a low-dose CT lung screening. Patients can now be safely screened at lower doses without sacrificing the quality of the diagnostic imaging thanks to newly developed dose reduction techniques
- Screenings can assist doctors in detecting cancer at an earlier stage, which makes it easier to treat. Lung cancer mortality rates have decreased by 20% so far, and if more patients get access to screening, they may continue to decline (Edelman et al., 2020, p. 1140). The underutilization of LDCT is a result of numerous obstacles that patients and clinicians must overcome. Yet, answers to these problems offer hope for higher screening rates
- There are risks and benefits to every medical procedure that a patient should think about before deciding to participate. All individuals with a high risk should, however, strongly consider low-dose lung screening given the favorable results