Current Practices and Future Directions of LD-CT in Lung Cancer Screening

Alberto Gomez Perez, MBA, R.T.(R)(CT)

Lung cancer is the leading cause of cancer death in the United States.[1] Although early detection is associated with improved outcomes, the sensitivity of chest radiography is insufficient for detecting small or early lesions. Low-dose computed tomography (LD-CT) has become the preferred tool for screening high-risk adults because it detects clinically important nodules while limiting radiation exposure. Eligibility criteria are based on the best available evidence, and shared decision-making is encouraged. In recent years, guidance regarding who should be screened and how screening is delivered has been updated.[2]

Epidemiology and Risk Factors

Most lung cancers are non–small cell lung cancer (NSCLC), with adenocarcinoma as the predominant subtype. Small cell lung cancer (SCLC) represents a smaller but more clinically aggressive fraction of lung cancers.[3] Cigarette smoking remains the dominant risk factor. People who smoke have approximately a 10- to 20-fold higher risk than do people who have never smoked, and risk increases with cumulative exposure (pack-years) and age.[4,5] Additional determinants increasingly recognized in screening policies and patient counseling include family history, hereditary syndromes, and environmental exposures such as radon and ambient fine particulate air pollution (ie, PM2.5).[6,7] The International Association for the Study of Lung Cancer Screening and Early Detection Committee's 2023 review summarized biological and epidemiological links between air pollution and lung cancer and highlighted synergy with smoking, reinforcing the need to factor nontobacco risks into outreach and communication.[4,6]

Hereditary predisposition, although a less common determinant, is clinically relevant. Germline alterations, including epidermal growth factor receptor mutations (eg, T790M, R776H, P848L) and tumor-suppressor syndromes such as Li-Fraumeni, can elevate lifetime risk independent of smoking status and often are associated with adenocarcinoma presenting at younger ages.[6] When aspects of a patient's personal or family history raises suspicion, referral for genetic counseling and tailored screening discussions is warranted.[6,7]

Eligibility for Low-Dose CT Screening

LD-CT chest protocols are optimized to minimize dose while preserving sensitivity for lung nodule detection. The typical mean effective dose per screening examination is approximately 1.5 mSv, one-quarter to one-fifth of the dose used in conventional chest CT.[8] Quality is maintained through thin-slice acquisition and modern noise-reduction methods such as iterative or deep learning reconstructions.[8,9]

Screening eligibility and interval recommendations differ slightly among authorities and continue to evolve. In 2021, the U.S. Preventive Services Task Force (USPSTF) recommended annual LD-CT screening for adults aged 50 to 80 years with a 20 pack-years or

more smoking history who currently smoke or have quit smoking in the past 15 years. Screening stops if the person has been smoke-free for 15 years or if curative treatment is no longer an option.[5] The 2023 American Cancer Society (ACS) guidelines also recommended annual LD-CT screening for asymptomatic adults aged 50 to 80 years with a 20 pack-years or more smoking history, yet removed years since quitting as an eligibility criterion for former smokers, emphasizing shared decision-making and cessation support.[1] Large randomized trials have shown that LD-CT screening is associated with earlier-stage lung cancer detection and reduced lung cancer–specific mortality compared with no screening.[2,5]

Programmatic quality relies on consistency in technologist-driven protocol, patient positioning, adherence to accreditation standards, and structured reporting.[2] Programmatic quality hinges on standardized LD-CT protocols that balance radiation dose reduction with adequate image quality, including thin-slice acquisition and appropriate reconstruction methods. Patients are positioned supine with arms *raised to minimize beam hardening artifacts and* ensure full lung coverage. Screening results are reported using structured systems such as the American College of Radiology Lung Screening Reporting and Data System (Lung-RADS), which standardizes terminology, risk categories, and management recommendations to support consistent follow-up and communication among care teams.[2]

Imaging Findings in NSCLC and SCLC

LD-CT screening detects peripheral and central tumors. A 2024 analysis of CT patterns throughout major histologies detailed morphologies for NSCLC and SCLC and offered practical descriptors that improve communication between radiologic technologists and radiologists during screening and triage.[3] Key CT imaging patterns in lung cancer screening are[3]:

- adenocarcinoma (NSCLC) – ground-glass or part-solid nodules, often peripheral in location, with subtle margins that benefit from thin-slice reconstruction and interval follow-up
- other NSCLC subtypes – solid nodules or masses with spiculated or irregular margins
- SCLC – centrally located bulky masses frequently associated with mediastinal lymphadenopathy (nodal enlargement), reflecting rapid growth and early dissemination

Advantages and Disadvantages of LD-CT Screening

The benefits of LD-CT screening have been established by randomized trials and population modeling and underpin USPSTF and ACS recommendations.[2] LD-CT screening enables earlier diagnosis and is associated with reduced lung cancer–specific mortality in high-risk adults.[2] The value of this screening is maximized when programs are built on[2]:

- careful integration of emerging tools (eg, artificial intelligence)
- clear communication
- consistent imaging and screening techniques
- high levels of technical quality
- reliable follow-up workflows
- standardized interpretation
- structured management

However, LD-CT also has disadvantages. Among large screening trials, false-positive rates have ranged from approximately 20% to 25% at baseline screening, although most cases are resolved with follow-up imaging instead of invasive procedures. Estimates of overdiagnosis vary but are generally reported in the range of 5% to 20%, and incidental findings, commonly in the neck, chest, and upper abdomen, are identified in up to one-third of LD-CT screening examinations.[5,10,11] An American College of Radiology (ACR) quick reference guide summarized frequent incidental findings and management pathways for screening programs.[10] The 2021 USPSTF evidence review also cataloged false positives, incidentalomas, and psychological distress as measurable harms mitigated by current protocols for managing nodules.[5,10,11]

Psychological responses to indeterminate nodules are not trivial. Recent multicenter qualitative work conducted in United Kingdom screening sites found that communication quality, especially clear explanations of what a nodule is and what surveillance entails, substantially influences patient anxiety level and adherence during follow-up. Evidence suggests that

distress often is short term and can be moderated by supportive, consistent messaging; well-structured letters; or brief consultations.[11]

Structured reporting and data systems such as the ACR Lung Screening Reporting and Data System (Lung-RADS) help standardize terminology, risk categories, and management to reduce unnecessary workups and variability. The Lung-RADS 2022 update refined categories for atypical cysts, juxtapleural and airway-centered nodules, growth definitions, and stepped management. Related programs should cite Lung-RADS and ensure precise, accessible references to the current version of Lung-RADS in protocols and patient communications.[2]

Nodule Assessment and Follow-up

Diameter alone is insufficient for assessing many subsolid nodules. Volumetric analysis and growth rate improve risk estimation when acquisition and reconstruction are consistent throughout examinations.[12] Findings from the Dutch-Belgian Randomized Lung Cancer Screening (NELSON) trial emphasized the importance of semiautomated volumetry, reproducible technique, and algorithmic follow-up intervals to maintain sensitivity while reducing unnecessary repeat imaging and follow-up examinations.[12] These findings relate to technologist practice, specifically patient positioning, slice thickness, kernels, and dose, which affect reliability of volumetry.[12]

Artificial Intelligence in LD-CT Screening

Artificial intelligence currently contributes to areas beyond detection. Sybil, which is a deep learning model trained on baseline LD-CT, predicts 1- to 6-year future lung cancer risk, thereby enabling discussions about individual-level surveillance intensity.[9] A recalibrated lung cancer prediction convolutional neural network model applied to National Lung Screening Trial images was found to improve 1-year risk prediction compared with Lung-RADS and statistical models and might safely identify candidates for biennial rather than for annual follow-up without increasing delayed diagnosis.[13] For radiology teams, these tools can help prioritize worklists, automate measurements, and support standardized reporting. For technologists, the tools offer assistive checks on positioning and image adequacy. Rigorous external validation and bias monitoring remain prerequisites for routine adoption.[9,13]

Future Directions

Program expansion should pair equitable access with thoughtful eligibility criteria that account for environmental risk, family history, and comorbidity while maintaining the simplicity needed for primary-care adoption. Embedding smoking-cessation interventions into screening pathways improves net benefit and aligns with guideline intent.[1] Educating patients in advance about the frequency and meaning of indeterminate nodules can reduce levels of distress and improve adherence to surveillance.[11] Sustained quality requires protocol discipline, Lung-RADS–based reporting, and capture of outcomes through registries.

Conclusion

LD-CT screening has helped reshape lung cancer control by enabling diagnosis earlier and lowering mortality in high-risk adults. The value of this screening is maximized when programs are built on consistent imaging and screening techniques, structured and consistent screening protocols, clear communication, and careful integration of emerging tools such as artificial intelligence. With these elements in place, LD-CT screening can continue to help screen for lung cancer while minimizing avoidable harms such as unnecessary repeat imaging, excessive radiation exposure, and potentially unnecessary procedures.

Alberto Gomez Perez, MBA, R.T.(R)(CT), is radiologic technologist and health care leader at Tu Salud Medical Centers in Miami Gardens, Florida.

References

1. Wolf AMD, Oeffinger KC, Shih TY, et al. Screening for lung cancer: 2023 guideline update from the American Cancer Society. *CA Cancer J Clin.* 2024;74(1):50-81. doi:10.3322/caac.21811
2. American College of Radiology. Lung-RADS (Lung CT Screening Reporting and Data System). Updated 2022. Accessed September 16, 2025. https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Reporting-and-Data-Systems/Lung-RADS

3. Ciofiac CM, Mămuleanu M, Florescu LM, Gheonea IA. CT imaging patterns in major histological types of lung cancer. *Life (Basel)*. 2024;14(4):462. doi:10.3390/life14040462
4. Berg CD, Schiller JH, Boffetta P, et al; International Association for the Study of Lung Cancer (IASLC) Early Detection and Screening Committee. Air pollution and lung cancer: a review by International Association for the Study of Lung Cancer Early Detection and Screening Committee. *J Thorac Oncol*. 2023;18(10):1277-1289. doi:10.1016/j.jtho.2023.05.024
5. U.S. Preventive Services Task Force, Krist AH, Davidson KW, et al. Screening for lung cancer: U.S. Preventive Services Task Force recommendation statement. *JAMA*. 2021;325(10):962-970. doi:10.1001/jama.2021.1117
6. Liu M, Niu X, Liu H, Chen J. Germline EGFR mutations in lung cancer (Review). *Oncol Lett*. 2023;26(1):282. doi:10.3892/ol.2023.13868
7. Benusiglio PR, Fallet V, Sanchis-Borja M, Coulet F, Cadranel J. Lung cancer is also a hereditary disease. *Eur Respir Rev*. 2021;30(162):210045. doi:10.1183/16000617.0045-2021
8. Hendrick RE, Smith RA. Benefit-to-radiation-risk of low-dose computed tomography lung cancer screening. *Cancer*. 2024;130(2):216-223. doi:10.1002/cncr.34855
9. Mikhael PG, Wohlwend J, Yala A, et al. Sybil: a validated deep learning model to predict future lung cancer risk from a single low-dose chest computed tomography. *J Clin Oncol*. 2023;41(12):2191-2200. doi:10.1200/JCO.22.01345
10. Dyer DS, White C, Conley Thomson C, et al. A quick reference guide for incidental findings on lung cancer screening CT examinations. *J Am Coll Radiol*. 2023;20(2):162-172. doi:10.1016/j.jacr.2022.08.009
11. Katsampouris E, Creamer AW, Prendecki R, et al. Patients' experiences of, and psychological responses to, surveillance for pulmonary nodules detected through lung cancer screening. *BMJ Open Respir Res*. 2025;12(1):e002498. doi:10.1136/bmjresp-2024-002498
12. Zhong D, Sidorenkov G, Jacobs C, et al. Lung nodule management in low-dose CT screening for lung cancer: lessons from the NELSON trial. *Radiology*. 2024;313(1):e240535. doi:10.1148/radiol.240535
13. Landy R, Wang VL, Baldwin DR, et al. Recalibration of a deep learning model for low-dose computed tomographic images to inform lung cancer screening intervals. *JAMA Netw Open*. 2023;6(3):e233273. doi:10.1001/jamanetworkopen.2023.3273