Impact of Early Diagnosis in Lung Cancer

Stephen Kovacs, DO

Noah Medical

Lung cancer – the leading cause of cancer death

Lung cancer, regarded as the leading cause of cancer death worldwide,[1] is expected to have affected ~240,000 people in US in 2023.[2]

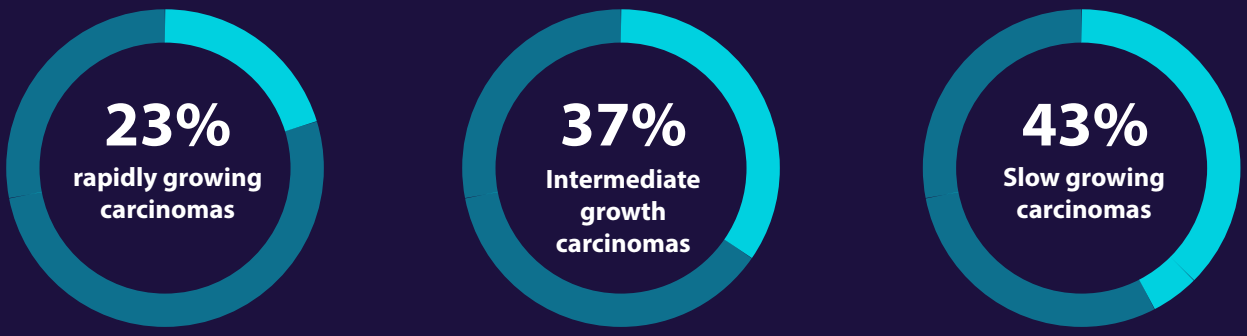
Although the incidence and mortality of lung cancer in the US has been declining annually at 2% (2010-2019) and 4.1% (2011-2020), respectively,[3] it still claims ~125,000 lives every year.[2]

Shorter tumor doubling time correlates with lower 5-yr survival rate

Tumor volume doubling time (VDT), the number of days it takes for the nodule to double in volume, is a clinically relevant metric in lung cancer screening. Lung cancer is estimated to take an average of 166 days to double in volume. At 222 days, adenocarcinoma had a slower VDT than squamous cell (115 days), large cell (67.5 days), and small cell (86 days) carcinomas.[4]

The 5-year survival rate for rapidly growing carcinomas (VDT<110 days) was 23%, for intermediate growth carcinomas (VDT between 110 – 252 days) was 37%, and for slow growing carcinomas (VDT>252 days) was 43%.[4]

5-year survival rate



As the cancer grows, it progresses in its stage by metastasizing to the lymph nodes, neighboring tissues, and other organs, making treatment more challenging.

Unfortunately, three quarters of patients with lung cancer are diagnosed at stage III or IV, by which stage the cancer would have spread to lymph nodes or other organs and becomes incurable.[5]

Early detection of **lung cancer** offers several clinical and economic benefits

Clinical

a) 5-year survival rates are much higher for earlier stages than later stages. For non-small cell lung cancer (NSCLC), the 5-year survival rate for stage 1A is 92% v/s 10% for stage IV[6]

b) Early detection permits surgical resection, the best strategy for patients with strong clinical suspicion of stage I and II lung cancer[7]

c) Treatment options could require fewer hospital visits,[8] which in turn could help reduce the risk for nosocomial infections

d) Higher likelihood of success for immune-related anti-tumor and targeted therapies[7]

5-year survival rate for non-small cell lung cancer

92% Stage 1A **vs** **10%** Stage IV

Private, Medicare, and Medicaid pulmonary surgery average reimbursement

$41,500

per procedure

Average monthly cost of treating lung cancer

$7,000

Stage I

$21,000

Stage IV

Economic

a) Radical surgical resection followed by observation remains the best treatment strategy for early-stage NSCLC[9]; pulmonary surgeries generate an average reimbursement of $51K for Private, $29K for Medicare, and $23K for Medicaid ($41.5K/procedure weighted average)[10]

b) The cost of treating lung cancer was much higher for patients with stage IV lung cancer ($21,000/month) compared with patients with stage I lung cancer ($7,000/month)[8]

c) Treatment options for later stage diagnosis require more frequent hospital visits and are associated with lower survival,[8] which could be associated with higher indirect costs such as travel and transportation of patient, lost wages, rehabilitation expenses, palliative care, etc.

d) Higher early diagnosis rates, coupled with better survival rates, could lend an aura of "Center of Care Excellence" to the care facility, further driving patient volume and revenue

Various challenges exist with diagnosing lung cancer in early stages

The challenges can be broadly categorized into the following:

1. **Patient-dependent factors**
   a) Absence of symptoms in early stages[11]
   b) Symptoms ignored or deemed not important[5]
   c) Medical nihilism[5]
   d) Stigma around smoking[12]
   e) Fear that radiation exposure from screening could lead to cancer[12]

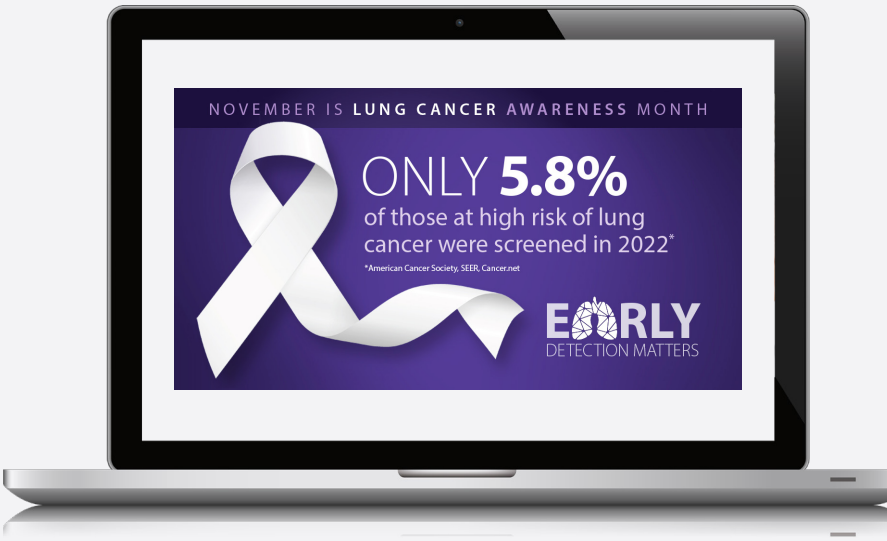
2. **Hospital protocol-dependent factors**
   a) Absence of an incidental lung nodule program, or poor guidelines on managing incidental nodule findings
   b) Coordination of screening and follow-up to ensure patients with suspicious lesions receive timely care[12]
   c) Limited familiarity with lung cancer screening guidelines[12]

3. **Lesion-dependent factors**
   a) Small size of lesion[13] and/or challenging location, making accurate biopsy challenging
   b) Poor visibility of lesion during biopsy, especially with ground-glass opacity (GGO) findings[13]

Addressing the **challenges** of **early detection**

1. Patient awareness and education

A lack of knowledge regarding lung cancer screening may negatively impact the health of high-risk patients. Studies have shown that educating patients using knowledge measurement tools, online videos on lung cancer screening, social media, etc., significantly increased the mean knowledge scores of study participants.[14]

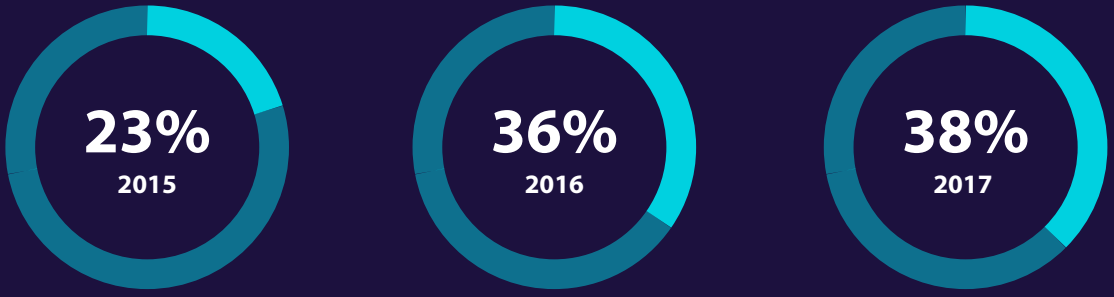


2. Comprehensive and integrated lung biopsy programs that incorporate incidental lung nodule programs and lung cancer screening programs

Although an increasing number of centers have developed incidental lung nodule management and screening programs, challenges in workload and workflow management, referral pathways, expertise, and systematic tracking remain barriers.[16]

A single center chart review from Blount Memorial Hospital in Tennessee showed that, after initiating a multi-disciplinary comprehensive and coordinated lung nodule program in 2016, the number of patients with lung nodules referred to the program increased over 2 years. The proportion of stage I-II cancer diagnoses increased from 23% prior to program implementation to 36% in year 1 and 38% in year 2.[16]

Stage I-II cancer diagnoses



3. Leveraging advanced robotic and imaging technologies to help biopsy-challenging lesions

Robotic-assisted bronchoscopic technologies have, in pre-clinical studies, demonstrated high navigational success and diagnostic yields.[17,18,19] One pre-clinical study has shown that robotic assistance allowed access to twice as many bronchial divisions than that of standard flexible bronchoscopy of equal outer diameter.[20]

However, only the Galaxy System™ has demonstrated a similarly high diagnostic yield in clinical trials, without the need for advanced imaging technologies.[21] One of the reasons for this could be attributed to correcting for CT-to-body divergence.

While other platforms require expensive dedicated CT imaging systems to correct for CT-to-body divergence, the Galaxy System's proprietary technology allows it to integrate with a variety of C-arms to recreate a tomographic image to correct for CT-to-body divergence. This capability, along with other features such as augmented fluoroscopy, a graphical overlay indicating the location of less visible GGOs, and Strikepoint technology, a measure of distance of the biopsy tool from the center of the lesion, offers confidence to the user in biopsying lesions in challenging locations as well as those with challenging visibility and size.

Conclusion

A combination of patient education, multi-disciplinary integrated lung nodule programs, and the use of advanced imaging-integrated robotic-assisted biopsy technologies can help identify, diagnose, and treat lung cancer at an earlier stage and improve clinical outcomes for patients while relieving some of the economic burden associated with lung cancer.

Bibliography

1) **International Agency for Research on Cancer.** GLOBOCAN Lung Cancer Facts Sheet 2020.

2) **American Cancer Society. Cancer Facts and Figures 2023.** Atlanta; American Cancer Society: 2023

3) **https://seer.cancer.gov/statfacts/html/lungb.html**

4) **Arai T, Kuroishi T, Saito Y, Kurita Y, Naruke T, Kaneko M. Tumor doubling time and prognosis in lung cancer patients:** evaluation from chest films and clinical follow-up study. Japanese Lung Cancer Screening Research Group. *Jpn J Clin Oncol.* 1994 Aug;24(4):199-204. PMID: 8072198.

5) **Kalinke L, Thakrar R, Janes SM. The promises and challenges of early non-small cell lung cancer detection: patient perceptions, low-dose CT screening, bronchoscopy and biomarkers.** *Mol Oncol.* 2021 Oct;15(10):2544-2564. doi: 10.1002/1878-0261.12864. Epub 2020 Dec 14. PMID: 33252175; PMCID: PMC8486568.

6) **American Cancer Society 2017**

7) **Li C, Wang H, Jiang Y, Fu W, Liu X, Zhong R, Cheng B, Zhu F, Xiang Y, He J, Liang W. Advances in lung cancer screening and early detection.** *Cancer Biol Med.* 2022 May 11;19(5):591–608. doi: 10.20892/j.issn.2095-3941.2021.0690. Epub ahead of print. PMID: 35535966; PMCID: PMC9196057.

8) **Gildea TR, DaCosta Byfield S, Hogarth DK, Wilson DS, Quinn CC. A retrospective analysis of delays in the diagnosis of lung cancer and associated costs.** Clinicoecon Outcomes Res. 2017 May 12;9:261-269. doi: 10.2147/CEOR.S132259. PMID: 28553128; PMCID: PMC5440037

9) **Indini A, Rijavec E, Bareggi C, Grossi F. Novel treatment strategies for early-stage lung cancer: the oncologist's perspective.** *J Thorac Dis.* 2020 Jun;12(6):3390-3398. doi: 10.21037/jtd.2020.02.46. PMID: 32642264; PMCID: PMC7330760.

10) **Estimating revenue, costs, and operating margin of any hospital-based thoracic surgery practice using a novel financial model.** Arman Ashrafi, Scott M. Atay, Sean C. Wightman, Takashi Harano, Anthony W. Kim.

11) **Bradley SH, Kennedy MPT, Neal RD. Recognising Lung Cancer in Primary Care.** *Adv Ther.* 2019 Jan;36(1):19-30. doi: 10.1007/s12325-018-0843-5. Epub 2018 Nov 29. Erratum in: Adv Ther. 2020 Apr;37(4):1701. PMID: 30499068; PMCID: PMC6318240.

12) **Barriers to Lung Cancer Screening Engagement from the Patient and Provider Perspective.** Gary X. Wang, Travis P. Baggett, Pari V. Pandharipande, Elyse R. Park, Sanja Percac-Lima, Jo-Anne O. Shepard, Florian J. Fintelmann, Efren J. Flores

13) **Li, Y., Yang, C.F., Peng, J. et al. Small (≤ 20 mm) ground-glass opacity pulmonary lesions: which factors influence the diagnostic accuracy of CT-guided percutaneous core needle biopsy?.** *BMC Pulm Med* 22, 265 (2022). https://doi.org/10.1186/s12890-022-02058-z

14) **Strong A, Renaud M. Using Social Media as a Platform for Increasing Knowledge of Lung Cancer Screening in High-Risk Patients**. *J Adv Pract Oncol.* 2020 Jul;11(5):453-459. doi: 10.6004/jadpro.2020.11.5.2. Epub 2020 Jul 1. PMID: 32974070; PMCID: PMC7508250.

15) **Ironmonger L, Ohuma E, Ormiston-Smith N, Gildea C, Thomson CS, Peake MD. An evaluation of the impact of large-scale interventions to raise public awareness of a lung cancer symptom.** *Br J Cancer.* 2015 Jan 6;112(1):207-16. doi: 10.1038/bjc.2014.596. Epub 2014 Dec 2. PMID: 25461805; PMCID: PMC4453621.

16) **LeMense GP, Waller EA, Campbell C, Bowen T. Development and outcomes of a comprehensive multidisciplinary incidental lung nodule and lung cancer screening program.** *BMC Pulm Med.* 2020 Apr 29;20(1):115. doi: 10.1186/s12890-020-1129-7. PMID: 32349709; PMCID: PMC7191779.

17) **Accuracy of a Robotic Endoscopic System in Cadaver Models with Simulated Tumor Targets: ACCESS Study** Alexander C Chen, Nicholas J Pastis, Michael S Machuzak, Thomas R Gildea, Michael J Simoff, Colin T Gillespie, Amit K Mahajan, Scott S Oh, Gerard A Silvestri PMID: 31805570

18) **A Prospective Randomized Comparative Study of Three Guided Bronchoscopic Approaches for Investigating Pulmonary Nodules: The PRECISION-1 Study** Lonny Yarmus, Jason Akulian, Momen Wahidi, Alex Chen, Jennifer P Steltz, Sam L Solomon, Diana Yu, Fabien Maldonado, Jose Cardenas-Garcia, Daniela Molena, Hans Lee, Anil Vachani; Interventional Pulmonary Outcomes Group (IPOG) PMID: 31678307

19) **"Tool-in-lesion" Accuracy of Galaxy System – A Robotic Electromagnetic Navigation Bronchoscopy With Integrated Tool-in-lesion-Tomosynthesis Technology: The MATCH Study** Krish Bhadra, MD, Otis B. Rickman, DO, Amit K. Mahajan, MD, and Douglas Kyle Hogarth, MD PMID: 37072895

20) **Chen AC, Gillespie CT. Robotic Endoscopic Airway Challenge: REACH Assessment.** *Ann Thorac Surg.* 2018 Jul;106(1):293-297. doi: 10.1016/j.athoracsur.2018.01.051. Epub 2018 Feb 24. PMID: 29486178.

21) **AABIP 2023 Abstract presentation by Dr Tajalli Saghaie (August 25th 2023) Preliminary results of the FRONTIER STUDY:** First Human Use of a New Robotic Electromagnetic Navigation Bronchoscopy with Integrated Tool-in-Lesion Tomosynthesis (TiLT) Technology (Galaxy System™) for Small Peripheral Pulmonary Nodules

For more information, please visit **noahmed.com**

Noah Medical