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The impostor of chest pain: a case of lung cancer mimicking angina



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Abstract

Chest pain is a common symptom with a complex etiology involving multiple organs and systems. Cardiovascular, digestive and respiratory diseases can cause chest pain. A single condition usually reformulates and can cause this symptom, but a combination of conditions can also cause it. This case reports a 69-year-old male suffered from recurrent chest pain. Coronary heart disease, gastroesophageal reflux disease and left lung adenocarcinoma were diagnosed successively for nearly 1 year. The patients focus on one disease, and the medical staff neglects to deal with multiple diseases simultaneously. Ambiguous evidence and patients' unmotivated attitudes towards treatment make early diagnosis of lung cancer difficult. Treatment for coronary heart disease and gastroesophageal reflux disease masks the symptoms of lung cancer to some extent, resulting in a skewed diagnostic focus. This report highlights the need for clinicians to improve communication with patients to enhance treatment adherence and provide comprehensive screening, identification, and treatment of chest pain etiologies to prevent delays in patient treatment. The findings also suggest that awareness of the therapeutic and prognostic impact of interstitial lung disease on lung cancer should be improved, which is essential for the development of clinical treatment protocols.

Keywords Chest pain, Lung cancer, Interstitial lung disease, Angina pectoris, Gastroesophageal reflux disease

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Introduction

Chest pain is a common symptom with a complex etiology involving multiple organs and systems [1]. With increasing exposure to risk factors for cardiovascular disease, the proportion of chest pain cases attributable to cardiogenic causes also rises [2, 3]. Ischemic cardiomyopathy can result in cardiac ischemia and hypoxia, disrupting normal myocardial metabolism and leading to chest pain [4, 5]. Aortic dissection forms a hematoma within the false lumen, compressing and stretching the aortic adventitia's nerve fibres, and stimulating the retropleural and retroperitoneal plexus, thereby causing chest pain [6]. The prevalence of gastroesophageal reflux disease (GERD) is 15-20% [7]. Long-term oral use of nonsteroidal anti-inflammatory drugs may damage the lower esophageal sphincter increasing the risk of the disease [8]. Gastroesophageal reflux of gastric and duodenal contents into the esophagus irritates the mucosa, leading to inflammation. This inflammatory response stimulates the nerve endings within the esophagus, which the patient perceives as chest pain [9].

Lung cancer is the leading cause of cancer-related mortality worldwide [10, 11]. Patients with early-onset lung cancer are asymptomatic and require proactive screening or physical examinations. Low-dose Computed Tomography (CT) screening for people at high risk of lung cancer may improve the early diagnosis and outcomes of those patients [12, 13]. Interstitial lung disease (ILD) is an independent risk factor for lung cancer [14, 15]. However, it is frequently overlooked in existing predictive models. Chest pain maybe caused by tumor invasion of the pleura, ribs, or nerves once the tumor has reached a significant size. In addition, herpes zoster induces chest pain due to viral infiltration into the intercostal nerves. Chest pain can also arise from compression or invasion of adjacent structures by mediastinal tumors once they reach a significant size.

This case reports the diagnostic and therapeutic course of a 69-year-old patient who was diagnosed with adenocarcinoma with multiple comorbidities, including coronary heart disease (CHD) and GERD. This case exemplifies the need for comprehensive and balanced treatment of chest pain, and the patient's attitude can affect the progression of the disease.

Case presentation

A 69-year-old male presented with chest pain to the Affiliated Hospital of Traditional Chinese Medicine of Southwest Medical University (SWMU). His chest pain had no obvious trigger and affected the subxiphoid process and the posterior back. The nature of the pain was unknown, and it was frequent and lasted for several minutes. Medical history included CHD, GERD, and pulmonary emphysema. Current medications include indobufen, clopidogrel bisulfate, metoprolol succinate sustained-release, rosuvastatin calcium, vonoprazan fumarate, and rebamipide. He is a civil servant who smoked for 30 years (averag 10/day) but has abstained for 20 years. He occasionally consumes alcohol, 4-8 times monthly. Physical examination revealed a palpably enlarged lymph node on the left supraclavicular bone, approximately 1.5×1.5 cm in size, hard, with poor mobility, ill-defined margins, and no tenderness. The lungs were hyperresonance on percussion sounds, and the respiratory sounds were weakened, with no rales. A mass measuring 3.0×3.0 cm was detected in the anterior branch of the left 5th rib, hard, with clear borders and tenderness. The abdomen was slightly depressed, with epigastric tenderness without rebound pain or muscle tension. The rest of the systemic investigations were normal. The results of the laboratory tests are shown in Table S1. The Electrocardiogram (ECG) is shown in Figure S1 A. Chest CT showed a nodule in the anterior segment of the upper lobe of the right lung (Fig. 1A). There was a nodule in the subpleural of the apical posterior segment of the upper lobe of the left lung (Fig. 2A). The anterior branch of the left 5th rib had localized bone destruction with a soft tissue nodular shadow (Fig. 2B). Dual-source CT and coronary CT angiography were further refined to evaluate the pulmonary nodule and coronary artery; the results are shown in Figs. 1B and 2C and D. Figure S2 illustrates skeletal representations of synaptic erosion under varying window settings across different body positions. He was admitted to the oncology department for consideration of the left lung nodule as peripheral lung cancer. A fine-needle aspiration of a soft tissue nodule in the anterior branch of his left 5th rib was performed on the 2nd day. Three days after the biopsy, the pathological diagnosis clarified the nature of his subpleural solid nodule in the apical posterior segment of the upper lobe of the left lung as adenocarcinoma (Fig. 3). He was diagnosed with a malignant tumor (adenocarcinoma) of the left lung (TxN3M1 IV). Genetic testing and immunoassay for lung cancer were refined on the 7th day. He refused to refine positron emission tomography (PET)-CT or bone scan to clarify whether there were metastases in other body parts. He developed bone metastases from his lung malignancy and was started on bisphosphonates for antiosteolysis and pain relief on the 12th day. On the 14th day, the genetic test report suggested TP53c. 736 A>G (p.M246V) mutation abundance: 35.1%. PD-L1 (IHC: 22C3) TPS: 30.0%; CPS: 30.0. He was treated with tirilizumab for phase I immunotherapy. He had intensive chest pain and high precision radiotherapy with P-GTV 51 Gy/15F (95%) was performed on the anterior branch of the left 5th rib metastasis on the 15th day, but was only performed once due to intolerance.



Fig. 1 Original image of an irregular solid nodule in the anterior segment of the upper lobe of the right lung. (**A**) 25 September 2024: Red arrow shows an irregular partially solid nodule of 2.3 × 1.9 cm in diameter in the anterior segment of the upper lobe of the right lung with adjacent pleural pulling. (**B**) 29 September 2024: Red arrow shows an irregular 2.3 × 1.9 cm diameter partially solid nodule in the anterior segment of the upper lobe of the right lung with adjacent pleural pulling. (**B**) an uarrow shows an irregular 2.3 × 1.9 cm diameter partially solid nodule in the anterior segment of the upper lobe of the right lung with adjacent pleural pulling. (**C**) 18 January 2023: Red arrow shows no nodule. (**D**) 14 March 2024: Red arrow shows an irregular subsolid nodule of approximately 2.3 × 1.7 cm in diameter in the anterior segment of the upper lobe of the right lung. (**E**) 15 April 2024: Red arrow shows an irregular partially solid nodule approximately 2.3 × 1.9 cm in diameter in the anterior segment of the upper lobe of the right lung. (**E**) 15 April 2024: Red arrow shows an irregular partially solid nodule approximately 2.3 × 1.9 cm in diameter in the anterior segment of the upper lobe of the right lung, with adjacent pleural pulling



Fig. 2 Original image of an irregular solid nodule in the anterior segment of the upper lobe of the left lung and soft tissue nodule of the anterior branch of the left 5th rib. (**A**) 25 September 2024: Red arrow shows an irregular solid nodule measuring 1.5×1.2 cm in diameter was found in the subpleura of the left lung's apical posterior segment of the upper lobe. (**B**) 25 September 2024: Red arrow shows localised bony destruction of the anterior branch of the left 5th rib accompanied by a soft-tissue nodular shadow of approximately 2.3×2.0 cm in diameter. (**C**) 29 September 2024: Red arrow shows an irregular solid nodule of approximately 1.4×1.3 cm in diameter, lobulated, with burr edges and pleural pulling, is present in the subpleura of the apical posterior segment of the left 1ung and is enhanced unevenly with mild enhancement. (**D**) 29 September 2024: Red arrow shows localised bony destruction of the anterior branch of the left 5th rib accompanied by a enhanced soft tissue nodule measuring approximately 2.3×2.0 cm. (**E**) 18 Jan 2023: Red arrow shows an irregular nodule approximately 0.6 cm in diameter in the anterior segment of the upper lobe of the left lung. (**F**) 14 March 2024: Red arrow shows an irregular solid nodule approximately 1.3×0.9 cm in diameter in the anterior segment of the upper lobe of the left lung. (**G**) 15 April 2024: Red arrow shows an irregular solid nodule approximately 1.4×0.9 cm in diameter in the subpleural area of the apical posterior segment of the upper lobe of the left lung. (**G**) 15



Fig. 3 Pathological examination. (A) HE staining. (B) Immunohistochemistry suggests that cytokeratin 7 (CK7) is expressed in cells, and the brown colour areas represent CK7 (+)



Fig. 4 The timeline of the visit

The timeline of his visit is shown in Fig. 4. Six months prior (19 March 2024), he presented to the Affiliated Hospital of SWMU with recurrent cough and expectoration. The results of the laboratory tests are shown in Table S1. The ECG is shown in Figure S1 B. Chest CT showed a nodule in the anterior segment of the upper lobe of the right lung, which did not exist on the previous CT scan 14 months ago (Fig. 1C, D). There was a larger nodule in the anterior segment of the upper lobe of the left lung than 14 months ago (Fig. 2E, F). According to the National

Comprehensive Cancer Network's guidelines for Lung Cancer Screening (version 2) [16], the patient needs to perform enhanced CT or PET-CT, or even biopsy or surgical resection. The doctor informed the patient and his family about his current condition and the need for further management, but he refused the suggestion.

Three weeks later (11 April 2024), he was examinated at the Department of Cardiovascular Medicine, the Affiliated Hospital of Traditional Chinese Medicine of SWMU for worsening chest pain. His chest pain has no obvious



Fig. 5 Original image of coronary angiography. (A) Red arrow shows diffuse stenosis of the middle left anterior descending branch, with the narrowest point shown by the arrow being approximately 85%. (B) Red arrow shows two stents were implanted in the middle anterior descending branch, and the lumen of the stented segment was well visualized, with no obvious abnormal shadows or signs of luminal narrowing

trigger and often presents as a dull ache that lasts about 1 min at a time. The likelihood of angina being caused by CHD is high since he has multiple risk factors for cardiovascular disease. The results of the laboratory tests are shown in Table S1. The ECG is shown in Figure S1 C. Coronary angiography showed diffuse stenosis of the mid-left anterior descending branch at about 85% at its narrowest point (Fig. 5A). The percutaneous coronary intervention was performed, and two stents were implanted in the left anterior descending stenosis (Fig. 5B). Chest CT scan showed the nodules in right lung (Fig. 1E) and left lung (Fig. 2G). Combined multidisciplinary opinion, the lung nodule has malignant characteristics, and there are pointers to improve the examination further to clarify the diagnosis. Unfortunately, he again refused further management. Fifteen days after discharge (08 May 2024), he was admitted to the gastroenterology department of this hospital for retrosternal pain and burning sensation. The results of the laboratory tests are shown in Table S1. The ECG showed sinus bradycardia without signs of an acute coronary event (Figure S1 D). A retrosternal burning sensation is a typical symptom of GERD. He was treated with suppression of gastric acid secretion, gastric mucosa protection, and gastroduodenal enterodynamics enhancement during a 13-day hospital stay. During the following 4 months, he attended the outpatient clinic of this hospital several times with chest pain and was treated with oral medication for CHD and GERD.

18 September 2024, he presented with hoarseness and a foreign body sensation in the throat. Direct laryngoscopy showed poor left vocal cord movement and normal proper vocal cord movement with poor closure (Figure S3).

Discussion

Both bone metastasis and pleural metastasis of lung cancer can cause chest pain. This patient's CT and pathological examinations have confirmed bone metastasis from lung adenocarcinoma, with a TNM stage of TxN3M1 IV. His chest pain is most likely caused by cancerous bone metastasis and requires strong opioid analgesics for treatment. However, further clarification regarding pleural involvement was not pursued, as it would not aid in diagnosis or treatment. Although he has CHD with a stent implanted, coronary CT angiography revealed no significant stenosis. For GERD, he has been on long-term oral vonoprazan fumarate and rebamipide therapy.

Here needs to be added part like that we presented the patient with nodular finding on chest CT scan first time observed on 24 Jan 2023, which revealed an irregular nodular shadow about 0.6 cm in diameter under the pleura of the anterior segment of the upper lobe of his left lung. However, as there were more scattered groundglass-like slightly hyperdense shadows in both lungs, pneumonia due to infection with novel coronavirus was considered, so the nodules were not well defined, no characteristic changes were found, and follow-up was not performed on time. Chest CT on both 14 March 2024 and 15 April 2024 suggested an enlarged subpleural nodule in the anterior segment of the upper lobe of the left lung, with an irregular morphology and increased solid components, within which vacuoles were seen in close association with blood vessels. According to the predictive model [17], he had a 71% probability of malignancy of lung nodule malignancy. Therefore, PET-CT or surgical biopsy may be considered directly. Scans from September 2024 revealed further enlargement of a subpleural

nodule, as well as possible metastasis of tumors in the mediastinum and ribs. The nodule was assessed as category 4X according to the lung imaging reporting and data system [18], and early pathological examination should be performed to clarify the diagnosis. Percutaneous rib aspiration biopsy was performed due to the small size of the primary lung lesion and the low rate of puncture positivity. Of note, this patient's chest CTs on 14 March 2024, 15 April 2024 and 25 September 2024 were all suggestive of a little scattered chronic interstitial inflammation in both lungs. Studies have shown that ILD is also an independent risk factor for lung cancer [14, 15]. However, most predictive models of lung cancer do not include ILD. ILD is a common adverse reaction after lung cancer treatment, and acute exacerbation of ILD during lung cancer treatment will significantly affect the guality and survival time of lung cancer patients [19]. Therefore, it is crucial to improve the understanding of the impact of ILD on the treatment and prognosis of lung cancer.

Lung cancer should be treated by clarifying the pathohistological diagnosis and molecular typing and deciding the treatment plan based on the test results [20, 21]. His genetic test report suggests no mutations in sensitive genes, Eastern Cooperative Oncology Group Performance Status > 3. Tirilizumab was eventually administered for immunotherapy care. Local radiotherapy was chosen to target specific localized lesions based on systemic treatment. For CHD, he needs regular ECG and cardiac ultrasound monitoring and continued use of antiplatelet agents, beta-receptor antagonists, Angiotensin-Converting Enzyme Inhibitors or Angiotensin II Receptor Blockers, and statins to reduce cardiac burden and prevent thrombosis. Intensive monitoring of cardiac and gastrointestinal adverse effects is required due to cardiovascular and gastrointestinal disorders in patients. Interactions between multiple drugs should also be considered to avoid adverse effects on the body. A multidisciplinary approach, involving cardiologist, gastroenterologists, surgeons, pulmonologists, and oncologists, to optimize patient treatment [22].

The patient's unmotivated attitude led to the progression of the disease. Although he was in a good financial situation, he missed the opportunity to treat his lung cancer at an early stage because he repeatedly refused to be diagnosed with a biopsy. Literature data showed that one study that included 55,704 patients found that 2.6% were reluctant to undergo surgical treatment [23]. Reasons for this include lack of knowledge about the disease, fear of surgery and financial burden. Therefore, medical staff should strengthen doctor-patient communication to establish a good doctor-patient relationship and enhance patients' compliance with treatment to reduce similar incidents. His current outcome is partly attributable to the combination of multiple diseases. CHD and GERD mask the symptoms of lung cancer to some extent and lead to a skewed diagnostic focus. Improving chest pain by treating other diseases and equivocal evidence makes early diagnosis more difficult.

Conclusion

Pleura invasion and bone metastasis are common in Adenocarcinoma. The foci adjacent to the visceral pleura in the left upper lope or metastasis in the fifth rib could cause chest pain that might be confused with comorbidities, including angina and gastroesophageal reflux. During clinical work, a thorough search for possible causes of chest pain that are fully identified should be conducted. Multidisciplinary approach and doctor-patient communication should be strengthened to enhance patients' compliance with treatment to reduce the occurrence of similar events and get better outcomes.

Abbreviations

GERD	Gastroesophageal reflux disease
CT	Computed tomography
ILD	Interstitial lung disease
CHD	Coronary heart disease
SWMU	Southwest Medical University
ECG	Electrocardiogram
PET	Positron emission tomography
ECOG-PS	Eastern Cooperative Oncology Group Performance Status

Supplementary Information

The online version contains supplementary material available at https://doi.or g/10.1186/s12890-025-03663-4.

Supplementary Material 1	
Supplementary Material 2	
Supplementary Material 3	
Supplementary Material 4	

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Author contributions

DZ and ML have mainly made substantial contributions to the conception and design of the study and contributed to the refinement of the study protocol. DZ, MC, LL and YQ drafted the manuscript and revised it critically for important intellectual content. XZ analyses digestive disorders. YX contributed to the methodology for the assessment of pulmonary nodules. QL analyses vocal cord paralysis. YZ, GL and YJ criticised the manuscript. PL and ML overviewed the manuscript.

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Data availability

All data generated or analysed during this study are included in this published article and its [supplementary information files].

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Written informed consent for publication of their clinical details and/or clinical images was obtained from the patient. A copy of the consent form is available for review by the Editor of this journal.

Competing interests

The authors declare no competing interests.

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References

- Pitts SR, Niska RW, Xu J, Burt CW. National hospital ambulatory medical care survey: 2006 emergency department summary. Natl Health Stat Rep. 2008;7:1–38.
- Amsterdam EA, Wenger NK, Brindis RG, Casey DE Jr, Ganiats TG, Holmes DR Jr, Jaffe AS, Jneid H, Kelly RF, Kontos MC, Levine GN, Liebson PR, Mukherjee D, Peterson ED, Sabatine MS, Smalling RW, Zieman SJ, ACC/AHA Task Force Members; Society for Cardiovascular Angiography and Interventions and the Society of Thoracic Surgeons. 2014 AHA/ACC guideline for the management of patients with non-ST-elevation acute coronary syndromes: executive summary: a report of the American college of cardiology/american heart association task force on practice guidelines. Circulation. 2014;130:2354–94.
- Cullen L, Greenslade J, Merollini K, Graves N, Hammett CJ, Hawkins T, Than MP, Brown AF, Huang CB, Panahi SE, Dalton E, Parsonage WA. Cost and outcomes of assessing patients with chest pain in an Australian emergency department. Med J Aust. 2015;202:427–32.
- Brown AF, Cullen L, Than M. Future developments in chest pain diagnosis and management. Med Clin North Am. 2010;94:375–400.
- Marks EM, Chambers JB, Russell V, Bryan L, Hunter MS. The rapid access chest pain clinic: unmet distress and disability. QJM. 2014;107:429–34.
- Pape LA, Awais M, Woznicki EM, Suzuki T, Trimarchi S, Evangelista A, Myrmel T, Larsen M, Harris KM, Greason K, Di Eusanio M, Bossone E, Montgomery DG, Eagle KA, Nienaber CA, Isselbacher EM, O'Gara P. Presentation, diagnosis, and outcomes of acute aortic dissection: 17-Year trends from the international registry of acute aortic dissection. J Am Coll Cardiol. 2015;66:350–8.
- Eusebi LH, Ratnakumaran R, Yuan Y, Solaymani-Dodaran M, Bazzoli F, Ford AC. Global prevalence of, and risk factors for, gastro-oesophageal reflux symptoms: a meta-analysis. Gut. 2018;67:430–40.
- Sugisaki N, Iwakiri R, Tsuruoka N, Sakata Y, Shimoda R, Fujimoto S, Eguchi Y, Fujimoto K. A case-control study of the risk of upper Gastrointestinal mucosal injuries in patients prescribed concurrent NSAIDs and antithrombotic drugs based on data from the Japanese National claims database of 13 million accumulated patients. J Gastroenterol. 2018;53:1253–60.

- Yang HJ, Chang Y, Park SK, Jung YS, Park JH, Park DI, Cho YK, Ryu S, Sohn CL. Nonalcoholic fatty liver disease is associated with increased risk of reflux esophagitis. Dig Dis Sci. 2017;62:3605–13.
- 10. Leiter A, Veluswamy RR, Wisnivesky JP. The global burden of lung cancer: current status and future trends. Nat Rev Clin Oncol. 2023;20:624–39.
- 11. Bade BC, Dela Cruz CS. Lung Cancer 2020: epidemiology, etiology, and prevention. Clin Chest Med. 2020;41:1–24.
- National Lung Screening Trial Research Team, Aberle DR, Adams AM, Berg CD, Black WC, Clapp JD, Fagerstrom RM, Gareen IF, Gatsonis C, Marcus PM, Sicks JD. Reduced lung-cancer mortality with low-dose computed tomographic screening. N Engl J Med. 2011;365:395–409.
- de Koning HJ, van der Aalst CM, de Jong PA, Scholten ET, Nackaerts K, Heuvelmans MA, Lammers JJ, Weenink C, Yousaf-Khan U, Horeweg N, van 't Westeinde S, Prokop M, Mali WP, Mohamed Hoesein FAA, van Ooijen PMA, Aerts JGJV, den Bakker MA, Thunnissen E, Verschakelen J, Vliegenthart R, Walter JE, Ten Haaf K, Groen HJM, Oudkerk M. Reduced Lung-Cancer mortality with volume CT screening in a randomized trial. N Engl J Med. 2020;382:503–13.
- Raghu G, Nyberg F, Morgan G. The epidemiology of interstitial lung disease and its association with lung cancer. Br J Cancer. 2004;91(Suppl 2):S3–10.
- Choi WI, Park SH, Park BJ, Lee CW. Interstitial lung disease and lung Cancer development: A 5-Year nationwide Population-Based study. Cancer Res Treat. 2018;50:374–81.
- Choi HK, Mazzone PJ. Lung Cancer screening. Med Clin North Am. 2022;106:1041–53.
- Gould MK, Ananth L, Barnett PG, Veterans Affairs SNAP, Cooperative Study Group. A clinical model to estimate the pretest probability of lung cancer in patients with solitary pulmonary nodules. Chest. 2007;131:383–8.
- Christensen J, Prosper AE, Wu CC, Chung J, Lee E, Elicker B, Hunsaker AR, Petranovic M, Sandler KL, Stiles B, Mazzone P, Yankelevitz D, Aberle D, Chiles C, Kazerooni E. ACR Lung-RADS v2022: assessment categories and management recommendations. J Am Coll Radiol. 2024;21:473–88.
- 19. Hata A, Schiebler ML, Lynch DA, Hatabu H. Interstitial lung abnormalities: state of the Art. Radiology. 2021;301:19–34.
- Riely GJ, Wood DE, Ettinger DS, Aisner DL, Akerley W, Bauman JR, Bharat A, Bruno DS, Chang JY, Chirieac LR, DeCamp M, Desai AP, Dilling TJ, Dowell J, Durm GA, Gettinger S, Grotz TE, Gubens MA, Juloori A, Lackner RP, Lanuti M, Lin J, Loo BW, Lovly CM, Maldonado F, Massarelli E, Morgensztern D, Mullikin TC, Ng T, Owen D, Owen DH, Patel SP, Patil T, Polanco PM, Riess J, Shapiro TA, Singh AP, Stevenson J, Tam A, Tanvetyanyanon T, Yanagawa J, Yang SC, Yau E, Gregory KM. Non-Small cell lung cancer, version 4.2024, NCCN clinical practice guidelines in oncology. J Natl Compr Canc Netw. 2024;22:249–74.
- Oncology Society of Chinese Medical Association. Chinese medical association guideline for clinical diagnosis and treatment of lung cancer (2024 edition). Natl Med J China|Natl Med J China. 2024;104:3175–213.
- 22. Pezzuto A, Terzo F, Graziani ML, Ricci A, Bruno P, Mariotta S. Lung cancer requires multidisciplinary treatment to improve patient survival: A case report. Oncol Lett. 2017;14:3035–8.
- Coffman AR, Tao R, Cohan JN, Huang LC, Pickron TB, Torgeson AM, Lloyd S. Factors associated with the refusal of surgery and the associated impact on survival in patients with rectal cancer using the National Cancer database. J Gastrointest Oncol. 2021;12:1482–97.

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