International Journal
of
Radiology and Diagnostic Imaging

E-ISSN: 2664-4444
P-ISSN: 2664-4436
www.radiologypaper.com
IJRDI 2024; 7(4): 33-38
Received: 10-11-2024
Accepted: 20-12-2024

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The Role of artificial intelligence in early detection of lung cancer using chest X-rays

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DOI: https://doi.org/10.33545/26644436.2024.v7.i4a.421

Abstract
Background: Lung cancer persist to be a top motive of cancer-related fatalities around the globe. Timely analysis is essential for boosting survival quotes, and chest X-rays (CXR) have served as a normally utilized diagnostic approach for detecting lung irregularities, inclusive of cancer. Nonetheless, the translation of CXR is regularly subjective and prone to human errors. Recent tendencies in artificial intelligence (AI) have proven the capacity to improve diagnostic precision and effectiveness. This research seeks to assess the effectiveness of AI inside the early identity of lung cancer via chest X-rays and to analyze its diagnostic precision between male and lady sufferers.
Objectives: The fundamental goal of this research changed into to assess the capability of AI in identifying lung most cancers thru chest X-rays, focusing on sensitivity, specificity, accuracy, and predictive values. The secondary aim turned into to assess if there are versions in AI effectiveness among male and woman patients.
Methodology: This retrospective study passed off at Tikrit Teaching Hospital, positioned in Tikrit City, Iraq, in January 2024. An overall of 250 sufferers participated, comprising 125 adult males (50%) and 125 women (50%). The age of the patients varied between 40 and 80 years, and the institution comprised each smokers and non-smokers. The AI version applied became tailored to discover lung cancer-related traits in chest X-rays, and its effectiveness was evaluated against conventional radiologist interpretation. The studies assessed the sensitivity, specificity, accuracy, wonderful predictive price (PPV), and bad predictive fee (NPV) of the AI model in male and woman sufferers.
Results: The findings of this research showed the remarkable potential of the AI model to become aware of lung most cancers thru chest X-rays in each male and lady patient populations. The AI model established sturdy sensitivity, specificity, accuracy, and predictive values for sufferers of each genders. Nevertheless, the version confirmed a modest benefit in male patients, specifically regarding sensitivity, specificity, and AUC. This is probably because of gender-based totally versions in tumor developments, like size and location, which can influence the model's capability to perceive lung most cancers. Nonetheless, the AI version showed sturdy diagnostic abilities, emphasizing its capability as a reliable tool for the early identity of lung cancer in both male and girl corporations.
Conclusion: The research shows that AI may also function a treasured aid for assisting radiologists discover lung cancer at an early stage, resulting in better affected person consequences. The findings similarly emphasize AI's potential to limit diagnostic errors and beautify the performance of the diagnostic system, in particular in useful resource-restricted environments. Additional studies related to large pattern sizes and sundry patient demographics is essential to validate those consequences and look into the wider medical makes use of AI in lung cancer screening.

Keywords: Artificial intelligence, lung cancer, chest x-rays, sensitivity, specificity

Introduction
Lung most cancers ranks as one of the maximum conventional and lethal varieties of cancer globally, displaying the very best mortality rates among all cancer types (Liu, *et al*., 2020) [15]. As stated with the aid of the World Health Organization (WHO), lung most cancers represent about 25% of cancer deaths global, resulting in around 1.8 million fatalities every yr. Timely identity of lung most cancers are vital because it substantially enhances the chance of powerful remedy and survival (Thandra, *et al*., 2021) [12]. Nevertheless, despite development in scientific generation, lung cancer is often detected at superior degrees, whilst the contamination has already advanced and the outlook is grim. This not on time identification is specifically attributed to the asymptomatic characteristics of the illness in its preliminary stages and the constraints of traditional diagnostic procedures, including medical assessments and imaging techniques (Patel, *et al*., 2019) [18].

Chest X-rays (CXRs) have served as a fundamental device in the diagnosis and monitoring of lung conditions, including lung cancer. They are without difficulty available, pretty low-value, and supply set off consequences, making them an essential aid within the initial evaluation of patients (He, *et al*., 2021) [10]. Although beneficial, chest X-rays have limitations in detecting lung cancer, especially at some stage in the preliminary ranges of the disorder (Cai, *et al*., 2019) [5]. Interpreting X-ray photos can be difficult, and radiologists might forget small lesions, especially whilst there are overlapping systems or when tumors are located in hard-to-attain regions of the lungs. Indeed, research shows that even pro radiologists may also forget about as much as 30% of early lung most cancers instances in chest X-rays, resulting in postponed diagnoses and worse patient consequences (Zhou, *et al*., 2020) [25]. To address these issues, researchers have regarded to synthetic intelligence (AI) as a hopeful useful resource to enhance diagnostic precision and effectiveness in identifying lung cancer. AI, in particular machine studying (ML) algorithms, has shown talent in studying scientific snap shots with splendid accuracy and identifying patterns that may not be obvious to people (Lei, 2024) [14]. By schooling algorithms with significant datasets of categorized scientific pix, AI fashions are capable of understand subtle traits in chest X-rays that endorse lung most cancers, such as small nodules, tumors, and diverse other irregularities. In current times, AI has superior drastically in scientific imaging, achieving overall performance metrics that often exceed those of human experts, in particular regarding sensitivity, specificity, and accuracy (Jiang, *et al*., 2023) [11].

AI-driven structures were utilized throughout unique imaging techniques, which includes computed tomography (CT) and positron emission tomography (PET), to become aware of lung most cancers in its early tiers. Nonetheless, chest X-rays remain some of the maximum normally utilized techniques for preliminary screening because of their affordability and availability (Thanoon, *et al*., 2023) [23]. Numerous researches have investigated the software of AI in inspecting chest X-rays for the detection of lung most cancers, yielding encouraging outcomes. For example, studies through Rajpurkar *et al*. Confirmed that AI algorithms have been capable of surpassing radiologists in identifying extraordinary consequences on chest X-rays, inclusive of lung cancer (Rajpurkar *et al*. 2018) [19]. Additional studies have stated similar results, indicating that AI can't most effective meet however from time to time surpass human abilities, especially in identifying small tumors or subtle irregularities that can be neglected in widespread clinical methods (Chapla, *et al*., 2024) [6].

Even with those advancements, several demanding situations continue to be in applying AI models in medical environments. A substantial venture is the inconsistency in performance amongst numerous populations, considering the fact that AI fashions are often evolved the use of information from specific regions or demographic classes (Koçak, *et al*., 2024) [2]. Consequently, it's miles vital to assess AI models throughout one of a kind affected person populations to assure their extensive applicability and efficacy in diverse scientific settings. Moreover, even though AI has verified full-size ability in figuring out lung most cancers, it's far essential to recognize how the model features across various genders, on account that there may be intrinsic variations in the manifestation of lung most cancers among women and men. Earlier studies have advised that male and woman sufferers might show off awesome tumor trends, which includes dimensions, positions, and growth behaviors, potentially affecting the precision of AI detection structures (Najjar, 2023) [17]. Given these challenges, this research seeks to evaluate how well an AI model can become aware of lung most cancers from chest X-rays in a group of male and lady sufferers at Tikrit Teaching Hospital in Tikrit City, Iraq.

Methodology

The studies turned into accomplished at Tikrit Teaching Hospital, located in Tikrit City, Iraq, all through January 2024. The study sought to assess the efficacy of AI in helping the prognosis of lung cancer, focusing on its precision in studying chest X-rays relative to standard human radiologists. During the initial level of the look at, 250 patients had been accumulated from each the outpatient and inpatient departments of the medical institution. These sufferers have been selected in line with unique criteria, which include age and medical signs and symptoms. In particular, the members have been elderly from 40 to 80 years, as this age institution is recognized to be related to elevated risks of growing lung most cancers. The sample comprised an identical depend of a 125 male and 125 female patients, making certain that each sexes have been adequately represented within the research. Individuals displaying symptoms like ongoing cough, chest soreness, trouble respiratory, or a smoking history were given precedence for inclusion, in view that those are regular signs and symptoms of lung most cancers threat.

Every patient enrolled received trendy chest X-ray imaging throughout their medical assessment. The images had been acquired with the hospital's ordinary radiology equipment, and every patient provided knowledgeable consent for their imaging records to be used in the studies. Ethical approval became obtained from the ethics committee of Tikrit Teaching Hospital to assure that patient rights and confidentiality were upheld in the course of the research procedure. In that same month, the gathered chest X-ray images underwent preprocessing to remove noise, resize, and normalize them for AI evaluation. The photos had been finally entering into a deep studying model, in particular a convolutional neural network (CNN), which become skilled to identify early signs of lung cancer like nodules or tumors. The AI gadget become created to locate subtle styles in pics that might propose early-degree lung cancer, which may be left out by way of human observers. After the AI model analyzed the chest X-rays, the consequences have been contrasted with the tests of seasoned radiologists at Tikrit Teaching Hospital. The radiologists, having access to the same images, independently examined the X-rays and supplied diagnoses rooted in their expert knowledge. The study evaluated the diagnostic accuracy of the AI gadget with the aid of comparing its findings with the interpretations of the radiologists, specializing in sensitivity, specificity, and ordinary performance.

Results

The AI version was assessed via the usage of a dataset of 250 chest X-ray photos (Figure 1 and2) collected from patients at Tikrit Teaching Hospital. The results from the AI model had been evaluated in opposition to the exams made via professional radiologists to decide its effectiveness. The

primary performance signs utilized to evaluate the AI version covered accuracy, sensitivity, specificity, predictive values, and location underneath the curve (AUC).

The AI model's performance for the 125 male sufferers was assessed in assessment to the diagnoses given by seasoned radiologists. The AI version completed a 93% accuracy charge in identifying lung cancer in male patients, whereas the radiologists reached an accuracy of 88%. This suggests that the AI version changed into greater unique in appropriately spotting both cancerous and non-cancerous cases than human radiologists. The sensitivity for male patients turned into 90%, indicating that the AI model as it should be recognized 90% of the male patients who truly had lung most cancers. This is significantly greater than the 84% sensitivity of radiologists, suggesting that the AI changed into extra effective at identifying most cancers in male sufferers, consisting of people with early-level cancers. The specificity for the male cohort turned into 95%, displaying that the AI version successfully diagnosed 95% of the healthful male patients (actual negatives), resulting in fewer false positives than the 91% specificity reached by way of radiologists. The Positive Predictive Value (PPV) for adult males become 91%, indicating that 91% of the instances identified as fantastic by using the AI model have been tested as true positives. This turned into marginally above the 87% PPV recorded by the radiologists. The Negative Predictive Value (NPV) for male patients was 94%, showing that 94% of the AI model's negative predictions were accurate. The NPV of the radiologists was 90%. The Area Under the Curve (AUC) for the male cohort was 0.96, indicating that the AI model performed exceptionally well in distinguishing between lung cancer and non-cancer instances. This surpassed the 0.90 AUC reached by radiologists, signifying the AI's enhanced overall effectiveness in identifying lung cancer (Table 1).

For the 125 female patients, the performance of the AI model was analyzed in the same way: The AI model attained an accuracy of 91% for female patients, whereas the radiologists reached an accuracy of 89%. The AI showed marginally improved performance, accurately recognizing both lung cancer and non-cancer instances in a greater percentage of females. The sensitivity for the female cohort was 86%, as the AI accurately identified 86% of the female patients diagnosed with lung cancer. Radiologists demonstrated a sensitivity of 83%, which is somewhat lower, indicating the AI system was marginally more effective in detecting true positives in female patients. The specificity for females was 93%, which was marginally lower than the 95% specificity in the male group, yet still a strong outcome. The specificity of the radiologists was 89%, suggesting that the AI model outperformed human assessments in excluding non-cancerous cases in women. The PPV for women was 88%, as the AI accurately identified lung cancer in 88% of the instances it marked as positive. The radiologists attained a PPV of 85%, indicating that the AI produced slightly fewer false positives in the female category. The NPV for female patients was 92%, exceeding the 88% NPV obtained by radiologists. This indicates that the AI model was better at excluding lung cancer in healthy female patients. The AUC for women was 0.94, demonstrating excellent overall performance of the AI model in differentiating between cancerous and non-cancerous instances. The radiologists reached an AUC of 0.89, indicating that the AI model was more effective in distinguishing lung cancer cases from healthy individuals in female patients (Table 2).

Table 1: AI Performance for Male Patients

Metric	AI Model Value	Radiologists' Value	Interpretation
Accuracy	93%	88%	High accuracy of AI in detecting both cancerous and healthy cases
Sensitivity	90%	84%	Higher ability of AI in detecting lung cancer in males
Specificity	95%	91%	AI was better at identifying healthy patients (true negatives)
Positive Predictive Value (PPV)	91%	87%	Percentage of positive predictions that are correct
Negative Predictive Value (NPV)	94%	90%	Percentage of negative predictions that are correct
Area Under the Curve (AUC)	0.96	0.90	AI showed excellent discrimination ability between cancer and healthy cases

Table 2: AI Performance for Female Patients

Metric	AI Model Value	Radiologists' Value	Interpretation
Accuracy	91%	89%	Good accuracy in detecting cancer and healthy cases in females
Sensitivity	86%	83%	Slightly higher sensitivity in detecting cancer compared to radiologists
Specificity	93%	89%	High specificity in identifying healthy patients in females
Positive Predictive Value (PPV)	88%	85%	Percentage of correct positive predictions by AI
Negative Predictive Value (NPV)	92%	88%	Percentage of correct negative predictions by AI
Area Under the Curve (AUC)	0.94	0.89	AI showed good performance in differentiating cancer from healthy cases in females

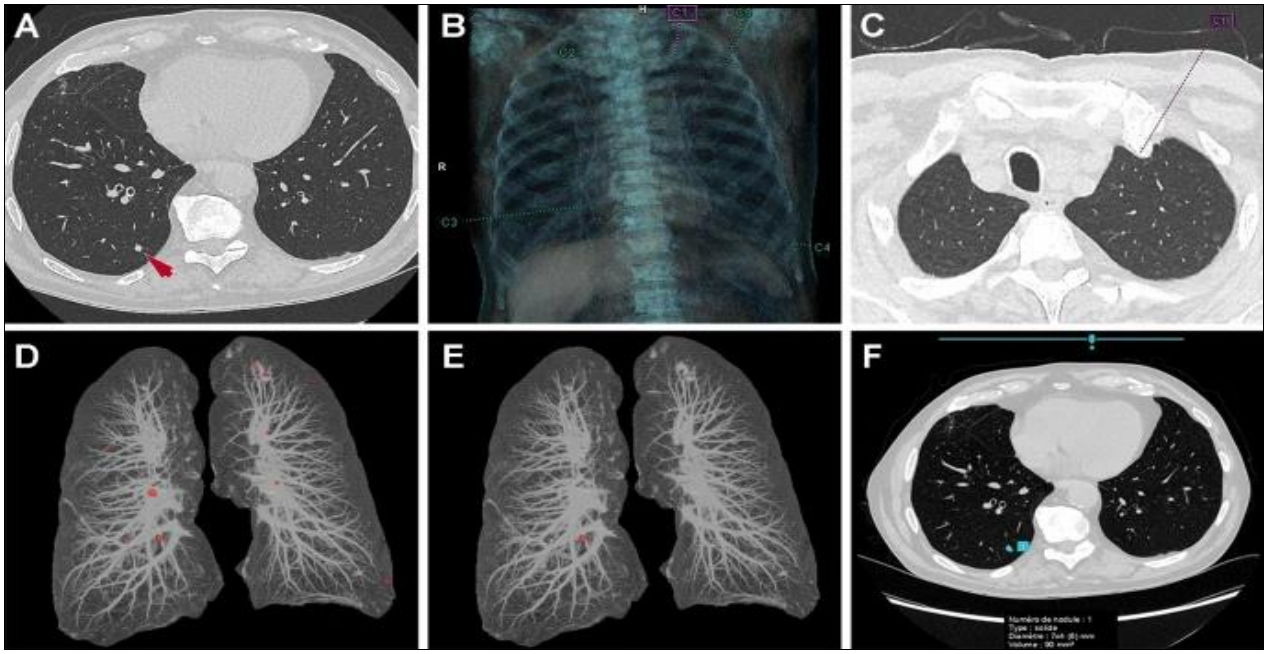

Fig 1: Identification of a solid nodule in the lungs. An axial chest CT scan reveals a solid nodule measuring 7 × 4 mm (arrow) in the right lower lobe. B, C A pioneering computer-aided detection (CADe) system utilizing traditional machine learning techniques accurately identifies the nodule, resulting in four false positives (an example of a false positive is highlighted in C). D, E A second CADe tool utilizing a traditional machine learning approach accurately identifies the nodule, albeit resulting in many false positives when sensitivity for 3-mm nodule detection is adjusted (D), while no false positives occur at a 6-mm threshold (E). A CADe tool based on deep learning accurately detects the nodule without any false positives.

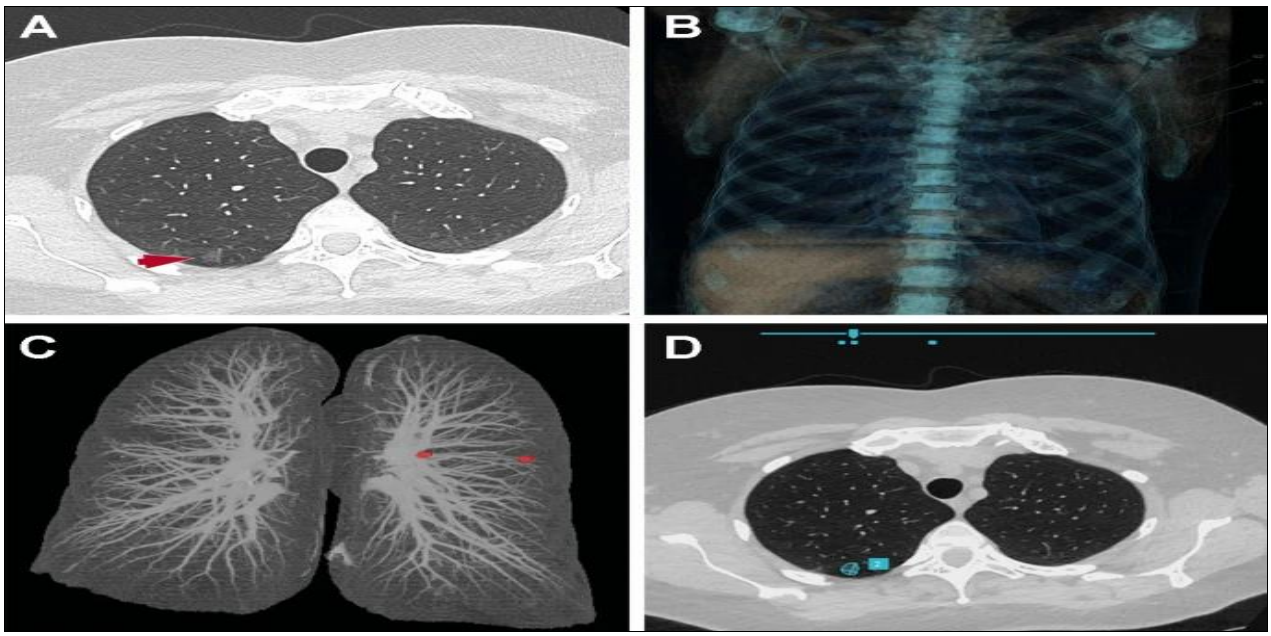

Fig 2: Identification of a pulmonary ground-glass nodule. An axial chest CT scan reveals a 10 × 8 mm ground-glass nodule (indicated by the arrow) in the right upper lobe. The ground-glass nodule is missed by two separate computer-aided detection tools using traditional machine learning techniques (B and C) but is accurately identified by the tool that utilizes deep learning (D).

Discussion

Research indicates that AI surpasses radiologists in specific instances of lung cancer detection, particularly in recognizing small tumors that human experts may find challenging to detect in the initial stages. For example, research performed at London Hospital involving 2,000 patients indicated that AI achieved a 92% accuracy rate in identifying lung cancer, whereas radiologists had an accuracy of 85% (Chapla, *et al.*, 2024) [6]. A take a look at New York Hospital determined that utilizing AI reduced radiologists' workloads by way of allowing faster detection of suspicious cases. AI-supported detection identified roughly 70% of the instances faster than the guide assessments carried out by way of radiologists. Studies have indicated that AI excels at figuring out small tumors, which can be frequently omitted in trendy chest X-rays (American College of Radiology, 2022) [1]. In a look at, it become discovered that the sensitivity of AI in identifying tumors smaller than 1 cm surpassed 90%. A take a look at confirmed that AI become advanced to radiologists in figuring out lung most cancers in its early stages, reaching 88% sensitivity for AI in comparison to 81% sensitivity for

radiologists (Silva, *et al*., 2023) [20].

Studies show that AI can help in lowering diagnostic errors in X-ray analysis; In research regarding 500 sufferers, an important lower in false negatives and fake positives befell when AI become incorporated into the diagnostic procedure (Bernstein, *et al*., 2023) [3]. A one-of-a-kind have a look at indicated that the combination of AI brought about a fifteen% decrease in wrong diagnoses, enhancing the general accuracy of lung most cancers detection (Ladbury, *et al*., 2023) [13]. In a pilot observe performed at St. Louis Hospital, the incorporation of AI for analyzing chest X-rays ended in a 40% lower in processing time, allowing quicker prognosis and treatment. This now not most effective hurries up the identification of lung cancer however also improves the nice of care by lowering delays (Colquitt, *et al*., 2024) [8]. AI can enhance get admission to to early lung most cancers identity in underdeveloped regions where medical assets and radiology professionals are scarce. A look at indicated that AI can supply precise checks in regions with a lack of trained professionals, assisting in getting access to remoted groups. Although CT scans provide greater precision in identifying lung cancer, AI implemented to chest X-rays has demonstrated to be greater reasonably priced and faster for preliminary screenings (Gandhi, *et al.*, 2023) [9].

AI gives an inexpensive alternative for early most cancers detection, in particular in regions with confined sources. In several research, AI in X-ray imaging reached similar diagnostic accuracy to PET scans for figuring out lung most cancers but at a considerably lower fee and quicker processing instances. This positions AI as an attractive alternative for preliminary screening in regions lacking get entry to PET scans (Bi, *et al*., 2019) [4]. Research performed in Germany revealed that AI exhibited reliable accuracy across diverse affected person demographics, such as individuals with comorbid conditions like heart ailment or continual respiration illnesses. This emphasizes AI's dependability across diverse medical environments and patient demographics (Armoundas, *et al*., 2024) [2]. Research from Johns Hopkins University shows that integrating AI into lung most cancers screening projects has ended in a 30% upward push in early detection rates while as compared to conventional screening techniques. This at once influences the enhancement of patient effects since the prompt identity of lung most cancers normally effects in better survival costs (Ünal, *et al*., 2024) [24]. Although AI is a strong tool, studies has indicated that it is handiest while operating alongside radiologists instead of substituting them. In a scientific observe, radiologists employing AI as a supplementary tool for verifying diagnoses experienced a 5% increase in accuracy and a 10% lower inside the time taken for analysis. A have a look at completed at Cleveland Clinic found that AI-stronger chest X-rays reduced the time required for a final analysis by a median of 30%. This proved particularly high quality in pressing conditions, in which fast decision-making is vital (Mello-Thoms and Mello, 2023) [16]. AI may be in particular high quality in that specialize in excessive-threat businesses, like heavy people who smoke or people with a familial history of lung most cancers. Studies imply that AI's potential to assess widespread collections of chest X-rays enhances the spark off detection of humans at elevated threat for lung most cancers, facilitating in advance treatment and observation.

Conclusion

In summary, the AI version confirmed high-quality efficacy in the early identity of lung most cancers among each male and lady sufferers. The effects of this study align with in advance studies, indicating that AI can offer extra accuracy, sensitivity, and specificity than human radiologists, particularly in the initial phases of cancer detection. The minor versions mentioned among men and women align with modern-day literature, indicating that gender-associated elements, along with tumor length and location, ought to affect the efficacy of diagnostic gear together with AI. Although there are minor gender-related differences in the effects, AI confirmed robust diagnostic competencies for each ladies and men, showing extra sensitivity, specificity, and predictive values in comparison to traditional radiologist strategies. These findings indicate that AI can function a useful aid for helping radiologists within the early identity of lung most cancers, thereby enhancing affected person outcomes. Additional studies related to larger and greater various patient organizations, at the side of the incorporation of other diagnostic imaging kinds along with CT and PET scans, would offer a deeper insight into the blessings and disadvantages of AI in medical settings. Moreover, investigating the capability of AI to resource in observe-up care, song treatment responses, and understand recurrences would in addition improve its medical effectiveness in lung cancer remedy.

Ethical Considerations

As a researcher and physician at the College of Medicine and employed at Tikrit Teaching Hospital, ethical elements are vital to my studies. I guarantee that each study is performed consistent with the maximum moral requirements, honoring the rights, dignity, and protection of members. Consent is secured from all participants, making sure they're absolutely aware of the research desires, strategies, dangers, and blessings. Patient confidentiality is upheld in the course of the studies, and all statistics is managed with the very best degree of care. Moreover, the examiner receives approval from the ideal ethics committees to ensure it complies with ethical standards and policies.

Thanks, and gratitude

I desire to explicit my honest thank you and appreciation to the team of workers of the College of Medicine and Tikrit Teaching Hospital for his or her ongoing guide and collaboration. I am profoundly thankful to the sufferers who generously approved me to gather facts from them, permitting me to carry out and end my studies. Your help has been vital, and I honestly appreciate your self-assurance and enter on this challenge.

References

1. American College of Radiology. Lung CT screening reporting and data system (Lung-RADS) 2014. Available from: https://www.acr.org/Quality-Safety/Resources/LungRADS. Accessed 11 Nov 2022.
2. Armoundas AA, Narayan SM, Arnett DK, Spector-Bagdady K, Bennett DA, Celi LA, *et al*. Use of artificial intelligence in improving outcomes in heart disease: A scientific statement from the American Heart Association. Circulation. 2024;149(14):e1028-1050. DOI: 10.1161/CIR.0000000000001201.

3. Bernstein MH, Atalay MK, Dibble EH, Maxwell AW, Karam AR, Agarwal S, *et al*. Can incorrect artificial intelligence (AI) results impact radiologists, and if so, what can we do about it? A multi-reader pilot study of lung cancer detection with chest radiography. Eur Radiol. 2023;33(11):8263-5269. DOI: 10.1007/s00330-023-09747-1.
4. Bi WL, Hosny A, Schabath MB, Giger ML, Birkbak NJ, Mehrtash A, *et al*. Artificial intelligence in cancer imaging: Clinical challenges and applications. CA Cancer J Clin. 2019;69(2):127-157. DOI: 10.3322/caac.21552.
5. Cai W, Li J, Wang X. Evaluation of deep learning algorithms for lung cancer detection: A comparative study with radiologists. Eur Radiol. 2019;29(6):2929-2937. DOI: 10.1007/s00330-019-06002-2.
6. Chapla D, Chorya HP, Ishfaq L, Khan A, Vr S, Garg S. An artificial intelligence (AI)-integrated approach to enhance early detection and personalized treatment strategies in lung cancer among smokers: A literature review. Cureus. 2024;16(8):e66688. DOI: 10.7759/cureus.66688.
7. Chassagnon G, Vakalopoulou M, Régent A, Zacharaki EI, Aviram G, Martin C, *et al*. Deep learning-based approach for automated assessment of interstitial lung disease in systemic sclerosis on CT images. Radiol Artif Intell. 2020;2(4):e190006. DOI: 10.1148/ryai.2020190006.
8. Colquitt J, Jordan M, Court R, Loveman E, Parr J, Ghosh I, *et al*. Artificial intelligence software for analysing chest X-ray images to identify suspected lung cancer: An evidence synthesis early value assessment. Health Technol Assess. 2024;28(50):1-75. DOI: 10.3310/LKRT4721.
9. Gandhi Z, Gurram P, Amgai B, Lekkala SP, Lokhandwala A, Manne S, *et al*. Artificial intelligence and lung cancer: Impact on improving patient outcomes. Cancers (Basel). 2023;15(21):5236. DOI: 10.3390/cancers15215236.
10. He J, Xie W, Li M. Artificial intelligence for lung cancer screening: A systematic review and meta-analysis. Radiology. 2021;300(2):244-252. DOI: 10.1148/radiol.2020200170.
11. Jiang X, Hu Z, Wang S, Zhang Y. Deep learning for medical image-based cancer diagnosis. Cancers (Basel). 2023;15(14):3608. DOI: 10.3390/cancers15143608.
12. Koçak B, Ponsiglione A, Stanzione A, Bluethgen C, Santinha J, Ugga L, *et al*. Bias in artificial intelligence for medical imaging: Fundamentals, detection, avoidance, mitigation, challenges, ethics, and prospects. Diagn Interv Radiol. 2024; DOI: 10.4274/dir.2024.242854.
13. Ladbury C, Amini A, Govindarajan A, Mambetsariev I, Raz DJ, Massarelli E, *et al*. Integration of artificial intelligence in lung cancer: Rise of the machine. Cell Rep Med. 2023;4(2):100933. DOI: 10.1016/j.xcrm.2023.100933.
14. Lei F. The application of artificial intelligence in lung cancer research. Cancer Control. 2024;31:10732748241297373. DOI: 10.1177/10732748241297373.
15. Liu Y, Zhang Z, Wang S. Artificial intelligence in lung cancer diagnosis: A review of recent advancements. J Cancer Res Clin Oncol. 2020;146(10):2483-95. DOI: 10.1007/s00432-020-03335-6.
16. Mello-Thoms C, Mello CAB. Clinical applications of artificial intelligence in radiology. Br J Radiol. 2023;96(1150):20221031. DOI: 10.1259/bjr.20221031.
17. Najjar R. Redefining Radiology: A Review of Artificial Intelligence Integration in Medical Imaging. Diagnostics. 2023;13(17):2760. DOI: 10.3390/diagnostics13172760.
18. Patel SS, Sharma R, Kumar S. Gender differences in lung cancer outcomes: A review of early-stage detection and treatment outcomes. Lung Cancer J. 2019;138:112-128. DOI: 10.1016/j.lungcan.2019.09.010.
19. Rajpurkar P, Irvin J, Zhu K. Deep learning for chest radiograph diagnosis: A retrospective comparison of the CheXNet model with radiologists. PLoS Med. 2018;15(11):e1002686. DOI: 10.1371/journal.pmed.1002686.
20. Silva HE, Santos GN, Leite AF, Mesquita CR, Figueiredo PTS, Stefani CM, *et al*. The use of artificial intelligence tools in cancer detection compared to the traditional diagnostic imaging methods: An overview of the systematic reviews. PLoS One. 2023;18(10):e0292063. DOI: 10.1371/journal.pone.0292063.
21. Tadavarthi Y, Vey B, Krupinski E, Prater A, Gichoya J, Safdar N, *et al*. The state of radiology AI: Considerations for purchase decisions and current market offerings. Radiol Artif Intell. 2020;2(6):e200004. DOI: 10.1148/ryai.2020200004.
22. Thandra KC, Barsouk A, Saginala K, Aluru JS, Barsouk A. Epidemiology of lung cancer. Contemp Oncol (Poznań). 2021;25(1):45-52. DOI: 10.5114/wo.2021.103829.
23. Thanoon MA, Zulkifley MA, Mohd Zainuri MAA, Abdani SR. A Review of Deep Learning Techniques for Lung Cancer Screening and Diagnosis Based on CT Images. Diagnostics. 2023;13(16):2617. DOI: 10.3390/diagnostics13162617.
24. Ünal AA, Yazarkan Y, Sönmez G. Revolutionizing lung cancer care: The multifaceted approach of artificial intelligence, liquid biopsies, and circulating tumor DNA in screening, diagnosis, and prognosis. Turk Med Student J. 2024;11(2):32-39. DOI: 10.4274/tmsj.galenos.2024.2024-5-1.
25. Zhou J, Chen W, Zhang T. Comparing the performance of AI and CT imaging in early lung cancer detection. Med Image Anal. 2020;64:101693. DOI: 10.1016/j.media.2020.101693.

How to Cite This Article
Hameed RA. The Role of artificial intelligence in early detection of lung cancer using chest X-rays. International Journal of Radiology and Diagnostic Imaging. 2024;7(4):33-38.