12

AI for Early Detection of Health Issues: Enhancing Accuracy and Reducing Human Error

Dr. Mamta Passi khokhar
Assistant Professor,
HOD, department of Zoology,
Govt.P.G . College for Women, Rohtak
passimamta2024@gmail.com

Abstract
Artificial Intelligence (AI) is altering the healthcare system by enhancing the quality of diagnostic tests, reducing human error, as well as supporting informed clinical decision-making. AI systems can identify subtle patterns of imaging, genomic, and clinical data that cannot be identified by a human observer through machine learning, deep learning, and multimodal data analysis. Artificial intelligence diagnostic tools, as well as clinical decision support, such as DXplain, improve the possibility of diagnosing particular diseases at an early stage and prescribing specific treatment, as well as facilitating clinical workflow. In spite of the fact that such developments have considerable benefits, their application raises ethical concerns, including the confidentiality of data, the transparency of algorithm, elucidation, and equal and just accessibility. These problems can be overcoming by using good governance, multidisciplinary collaboration, and developing explainable AI to enable one to be responsible when introducing AI into the healthcare field. In total, AI may be used to make healthcare more accurate, efficient, and patient-centered to improve its outcomes and accessibility.

Keywords: *Artificial Intelligence, Healthcare Diagnostics, Clinical Decision Support, Machine Learning, Deep Learning, Early Disease Detection, Diagnostic Accuracy.*

1. Introduction

The Artificial Intelligence (AI) is a disruptive technology in the sphere of medicine as it is able to change the process of medical diagnostic, clinical decision-making process, and patient care. With the help of the most sophisticated computational systems, machine learning, deep learning, and

multimodal data analysis, AI systems are capable of detecting complex patterns within medical imagery, genetic sequences, and clinical records, which cannot be detected by human clinicians in general (Khalifa and Albadawy, 2024; Ghaffar Nia, Kaplanoglu, and Nasab, 2023; Mirbabaie, Stieglitz, and Frick, 2021). It is also confirmed that AI is more accurate in the diagnostics of tumors, fractures, cardiovascular anomalies, and other neurological conditions and is better at the traditional radiological examination in the majority of cases, saving on time spent on the analysis process and making the working process more efficient (Nichols, Herbert Chan, and Baker, 2019; Rai, Yoo, and Dashkevych, 2025; Nazir et al., 2025; Li, Zhang, Yang, and Teng, 2024). In the same way, genetic and clinical information used in conjunction with AI has made it possible to have accurate diagnostics that can now be applied to an individual to classify the risks, detect diseases at the early stages, and develop an individualized treatment plan (Dias and Torkamani, 2019; Mirbabaie et al., 2021).

Besides, AI can process or minimize the cognitive load of the clinician, thus, presenting a more accurate diagnosis by reducing human error (Abimanyi-Ochom et al., 2019; Degnan et al., 2019; Van Cott, 2018; Khalifa and Albadawy, 2024). DXplain and its analogs, which enable clinicians to create a differential diagnosis, treatment plan, and make the case more cost-effective in the case of a diagnostically complex nature, are the examples of the AI use in the clinical decision support system (Castaneda et al., 2015; Elkin et al., 2010; Loeb, 2021; Mohammadabadi et al., 2024; Thammasitboon and Cutrer, 2013). These systems operate on large amount of data and evidence-based suggestions are arrived at that does not cancel out clinician expertise but rather supplements it in order to ensure that the number of wrong and timely decisions reduced.

Although AI can be used to make some drastic changes in the healthcare sector, its usage poses the important questions of ethical concern, such as data privacy, algorithm transparency, explainability, and fair access (Koonrungsesomboon, Laothavorn, and Karbwang, 2016; Pietilä, Nurmi, Halkoaho, and Kyngases, 2019; Guan, 2019, Amann et al., 2020). It is extremely important to make sure that the AI systems can be read, integrated into the clinical activities safely, and intensively controlled ethically to ensure that the technology of AI can ensure the safety of patients, integrity of clinician and credibility to society. In such cases of technical, clinical, and ethical issues, AI can potentially make healthcare more accurate, effective, and patient-centered

and increase the quality, access, and equality of medical care in the world.

2. Literature Review

Recent research has been concerning the rapid acquirement of algorithms to supplement sensitivity and specificity in an early detection. Some of the reviews and technical surveys plot the growth of machine learning and deep learning structures in radiology, pathology, and multimodal clinical data in diagnostic accuracy, as compared to other approaches (Khalifa and Albadawy, 2024; Li et al., 2024; Nichols, Chan and Baker, 2019; Mirbabaie, Stieglitz and Frick, 2021; Ghaffar Nia, Kaplanoglu and Nasab, 2023). Dias and Torkamani (2019) further expand on this and followed-up genomic and/or non-invasive focused reviews (Rai, Yoo and Dashkevych, 2025; Nazir et al., 2025) to genomic and molecular diagnostics, which confirms the fact that AI can identify traces of subtle clues that cannot be seen through a human eye. Each of these articles describes the built imaging pipelines (preprocessing, segmentation, classification), new modalities (holographic/advanced imaging, multimodal fusion) with the potential to propel the past and more accurate disease detection.

The fact that AI may be applied to the clinical setting to decrease the list of possible human errors leading to missed or delayed diagnosis is not just one of the largest themes of the whole bibliography but one of the largest opportunities of the contemporary literature. The foundational research on the sources of perceptual and interpretive error in radiology (Degnan et al., 2019) and workflow-based treatment of human error (checklists) (Abimanyi-Ochom et al., 2019) is the literature on the discovery of the cognitive and workflow causes of errors. It is demonstrated that the clinical decision support and knowledge-based systems (Castaneda et al., 2015; Elkin et al., 2010; Loeb, 2021) are cheaper and yield the optimal results in such instances when the diagnoses may be challenging. As noted by Thammasitboon and Cutrer (2013), they focus on the strategies of diagnostic reasoning and that, combined with AI prompts or tools generating differentiation can assist clinicians in avoiding cognition bias.

The last literature group is concluded on the fact that the benefit of early detection must have justifiable, explicable and ethically controlled practice. The idea that explainability is a prerequisite in both multidisciplinary (Amann et al., 2020) and practical best-practice explainable AI in healthcare 5.0 (Chattopadhyay, Barman and Lakshmi, 2025) is it apparent that clinicians need to be prepared to comprehend the type of thinking the models have so that they can accept and use AI outputs appropriately.

The protection of their subjects and data, governance, data protection and context-sensitive resource allocation (Guan, 2019; Al Sulaiman et al., 2025) are also declared as the basic ones, in particular, in the high-density or limited environment, the first-in-human work or qualitative research also brings up ethical principles (Koonrungsesomboon et al., 2016; Pietilä et al., 2019). Lastly, the structural analysis of the methodology will be required to formulate future research directions as domain-specific tests (Mohammadabadi et al., 2024) and structural review of the methods (Mirbabaie et al., 2021; Ghaffar Nia et al., 2023) imply the required transfer of the increased accuracy of the algorithms to the decreased human error and the enhanced population health.

3. AI-Driven Diagnostic Accuracy

The Artificial Intelligence (AI) is a comparably recent phenomenon in the field of healthcare diagnostics that has left a massive change in the accuracy and effectiveness of the disease identification. With the use of machine learning, deep learning, and other advanced imaging algorithms, AI systems will be capable of processing more complex medical data and making insights that in most instances might be better than those of humans. Artificial intelligence tools can be familiar with how to recognize the presence of small patterns that a human being might be unaware of, and therefore, are capable of predicting and identifying health issues much earlier and, consequently, predicting health outcomes in a more precise way (Khalifa and Albadawy, 2024; Ghaffar Nia et al., 2023). It is also stated by Khalifa and Albadawy (2024) that such kind of AI based diagnostic systems can make the accuracy even better in addition to reducing the duration needed to make the analysis in order to make more informed clinical decisions in time.

3.1. Artificial Intelligence in Diagnostics Image.

Diagnostic imaging has changed the medical image analysis and interpretation of medical images such as X-rays, CT scan, MRI and ultrasound in the effort to identify the disease at an early stage. High level machine learning models, and specifically the convolutional neural networks (CNNs) identify anomalies, small features and patterns that can only be observed by human observers when they are abundant. It has been proved that the AI-based solutions are capable of detecting a number of disorders, such as tumors, fractures, heart defects, and neurological diseases with the appropriate accuracy rates and even among experienced radiologists (Nichols et al., 2019; Rai et al., 2025). The tools are accurate and enable faster diagnostic process that provides faster turn around time and helps in mass screening programs. To give an example, the tumor detecting

algorithms can be applied to detect the malignant lesions at their initial stage, and can be used to improve the prognosis and minimize the invasiveness of the practises. Besides this, AI-based imaging can also provide low-inter-observer reliability and human error standard examination and more detailed, individualized, and practical diagnosis when added to multimodal data, e.g., genomic or clinical data (Mirbabaie et al., 2021; Dias and Torkamani, 2019).

3.2. Genomic and Clinical Data integration.

In addition to imaging, AI with genomic and clinical data can be used to offer accuracy in the diagnosis and individual health care. The AI models have the capability to analyze much of genomic information such as DNA sequence, gene expression and the mutation profile in addition to patient history, laboratory findings and imaging findings in order to develop healthy attempts to avert illness (Dias and Torkamani, 2019; Mirbabaie et al., 2021). The multimodal analysis assists in the formulation of personal diagnostic and treatment plans, which enhances the outcome of the patients and reduces the number of unnecessary tests or procedures. Besides, AI analytics can help to detect previously unknown connections between genetic markers and clinical phenotypes that can help to reveal biomarkers and better understand pathogenesis. Such datasets can also be combined to ensure that clinicians have access to real-time data on decision support which is based on evidence-based insights that may be used to plan diagnosis, prognosis, and treatment (Ghaffar Nia et al., 2023; Rai et al., 2025).

3.3. Competitive Advantages to Traditional Diagnostics.

The AI-based diagnostics is more precise, efficient and reliable in comparison with the conventional methods of diagnosis. The traditional methods tend to be experience-based and manual and are typically interpreted by clinicians subject to human error, fatigue and inter observer error. Nevertheless, systems based on AI are more accurate with big and complex data and identification of trends and outliers that cannot be identified by a human eye (Nichols et al., 2019; Khalifa and Albadawy, 2024). The skills enable the screening of the disease at an earlier stage, interventions, and also enhancement of prognosis. Division of images, identification of features, initial classification are common steps that are automated to help in saving clinician time and speeding up the workflow and the standardization helps the similar activity to be tried by different practitioners and facilities. Moreover, the approach to combining the imaging, genomic, and clinical data is also a feature of AI, and it can allow having a complete overview of the patient condition, which makes this more

knowledgeable and custom-tailored decision-making. Overall, it seems that the comparison of AI and conventional diagnostics is associated with its consistency, accuracy, speed, and the ability to provide the non-invasive, predictive, and personalized healthcare (Rai et al., 2025; Mirbabaie et al., 2021).

4. Reducing Human Error in Diagnostics

Another area of medicine where medical diagnosis can be observed as one of the largest causes of misdiagnosis, delayed treatment and poor patient prognosis is human error. These mistakes can occur on a variety of levels during the diagnostic process: at the level of perceptual mistakes and interpretive bias (with oversight included), cognitive bias (worsened by fatigue, workload, and a change in expertise of a clinician), and so on (Degnan et al., 2019; Van Cott, 2018). These malpractices are not only undermining safety of the patients but also raising costs of health care and reducing efficiency.

4.1. Human error in diagnostics is caused by the following reasons.

To decrease the amount of diagnostic errors, the causes of these errors should be familiar. The most common are perceptual (i.e., the misinterpretation of minor anomalies in medical images) and interpretive (i.e., the misclassification or the inaccurate estimation) ones (Degnan et al., 2019). The reality that clinicians might overlook crucial information during the working process increases even more risks of making errors because of the cognitive barriers, stress, and interruption (Van Cott, 2018). Medical information, such as imaging or laboratory results, and history of the patient, are complex and mutable, and even the diagnosis process is biased towards human factor.

4.2. Artificial intelligence in Diagnostic ErrorReduction.

The AI technologies will be capable of delivering effective solutions to address the human errors due to the supply of decision support, standardization of interpretations, and elimination of cognitive loads. The availability of complicated medical information, unusual patterns, and abnormalities that may go undetected by human viewers can be observed with the help of deep learning and machine learning algorithms (Khalifa and Albadawy, 2024; Nazir et al., 2025). A second opinion as offered by artificial intelligence may be reliable in encouraging clinician interpretation of imaging data to enhance diagnostic consistency and accuracies (Li et al., 2024). Moreover, image segmentation and features extraction are routine tasks that can be automated with the aid of the AI systems and enable the healthcare professionals to concentrate on the pie-level clinical reasoning and

reduce the number of errors that are committed because of fatigue.

4.3. Artificial Intelligence-Based Decision Support.

Artificial intelligence-based decision support systems are systems that combine imaging, clinical and genomic information in order to give evidence-based recommendations. Such systems can not only identify the possible inconsistencies in the diagnosis, but also provide possible alternative diagnosis, and clinicians can make corresponding decisions much quicker and more accurately (Khalifa and Albadawy, 2024; Li et al., 2024). Diagnosis procedure standardization will help AI minimize inter-observer inconsistency where the patients will be graded differently by different health practitioners and institutions.

5. Enhancing Clinical Decision-Making

Such a direction of AI deployment in a sphere as diagnostics to clinical decision support that will assist clinicians to make more appropriate, timely, and evidence-based choices is not unique in its transformative potential. The AI-based decision support systems enhance consistency, accuracy, and efficiency of the workflow in clinical practice because they process extensive and complicated data on patients (Castaneda et al., 2015; Mohammadabadi et al., 2024).

5.1. The Clinical Decision Support Overview of AI.

Clinical decision support (CDS) systems are AI software that also consumes the patient history, lab reports, and imaging and other clinical data and returns information and recommendations to act upon. These systems are set to minimize the ambiguity of the diagnosis, identification of possible treatment options and general patient outcomes. According to Loeb (2021), AI CDS systems will alternate, but not interfere with clinician expertise, i.e., medical professionals will be able to make good decisions when dealing with a complex or ambiguous case.

5.2. Artificial Intelligence (AI) Differential Diagnostic Systems.

Examples of cases of decision support systems that have been deployed in the production of differential diagnosis is artificial intelligence programs like the DXplain program that utilize patient specific data. The systems assist the clinicians in navigating the complicated systems that are related to the diagnosis process, especially those diseases that are rare or otherwise difficult to diagnose because of the complexity involved (Elkin et al., 2010; Wikipedia). These systems have been found to save money, enhance the precision of the diagnostics, and contributed to making the clinical processes less complicated by

demonstrating the conditions that were not previously taken into account (Thammasitboon and Cutrer, 2013).

5.3. Recommendations and Workflow Integration Reliable.

Decision support systems are AI-based systems that entail the utilisation of extensive data, such as clinical recommendations, research evidence and patient-specific data, to make evidence-based suggestions that are tailored. The systems improve clinical decision-making, clinical variability of care, and promote the initiatives of precision medicine (Castaneda et al., 2015; Khalifa, Albadawy, and Iqbal, 2024). The successful integration in the hospital workflow will guarantee the timeliness of the decision support that will not interfere with the latter and will supplement the knowledge of the clinicians (Mohammadabadi et al., 2024).

5.4. How to Enhance Clinical Decision-Making.

AI also aids in the treatment planning, risk categorization, and management of the patient not only in its diagnosis. It can improve the recommendations in the case when AI systems are being repeatedly taught new clinical data, which will become flexible enough to respond to new evidence (Thammasitboon and Cutrer, 2013; Loeb, 2021). These adaptation skills enable clinicians to become democrat decision makers and minimise error and maximise patient outcomes especially in problematic or high-stakes situations.

6. Ethical Considerations and Challenges

The introduction of the Artificial Intelligence (AI) to the healthcare sphere is associated with both fundamental benefits and ethical dilemmas and concerns. Like the creation of AI, stakeholders in the medical sector will have to grapple with such intricate problems as data privacy and transparency of algorithms and the danger of excessive dependency on automated systems (Guan, 2019; Al Sulaiman et al., 2025). Ethical deployment is needed to make sure that the credibility of the clinicians, along with the fairness of the accessibility to the care, is guaranteed to the patients.

6.1. Data Privacy and Security

The issues of data privacy and data security are critical since AI systems presuppose high volumes of patient data. When the unauthorized access, data theft, or other ill use of sensitive medical information is absent, patient confidentiality can be ensured (Koonrungsesomboon, Laothavorn, and Karbwang, 2016; Al Sulaiman et al., 2025). The implementation of a robust policy of data governance, encryption, and anonymization are then the key to

the implementation of ethical AI in healthcare.

6.2. Drawing from the ease of use concept, the researchers propose that a more coherent model with improved relateability will be more readily embraced.<|human|>Algorithms Transparency and Explainability, The researchers base their proposal on the ease of use concept, which states that a more rational model with better relateability will be more easily accepted.

Most AI models have a black-box nature that can pose a challenge to clinicians, patients and regulators. Without transparency, the mechanism of how AI can reach the recommendations that may undermine the trust and accountability, may not be understood (Amann et al., 2020; Chattopadhyay, Barman, and Lakshmi, 2025). Explainable AI (XAI) techniques are used to make the model decisions interpretable, such that clinicians can defend the use of AI in clinical practice, and maintain professional judgment and use AI understanding safely.

6.3. Sustaining Clinical Competence and Human Supervision.

Even though AI supplements the process of decision-making, the overuse of automated equipment may reduce diagnostic skills and critical thinking of clinicians (Thammasitboon and Cutrer, 2013; Pietilä et al., 2019). Ethics integration entails upholding the elements of human control, the clinicians must be in a position to apply their evaluative and judgmental abilities autonomously, particularly in the challenging or ambiguous cases. AI is not targeted at replacing human knowledge, but improving it.

6.4. Fairness, Distribution of Resources, and Good Governance.

AI implementation might lead to the disparity between the access to healthcare in the situation of unequal resource distribution or the models are trained using biased data (Guan, 2019; Al Sulaiman et al., 2025). Ethical governmental models are supposed to be of such nature that they ensure fair accessibility, equal share of resources and unremitting observation of any prejudice or unintentional repercussions. The first-in-human studies and new AI interventions need to adhere to strict ethical standards, as they are expected to make sure that patients are safe and trusted in society (Koonrungsesomboon et al., 2016).

7. Future Directions

The future of AI in healthcare diagnostics and clinical decision making is in creating systems, which are more explainable, adaptive, and integrated in normal clinical workflows. Explainable AI (XAI) will permit clinicians to comprehend the rationale underpinning

any AI-driven recommendation, which will help build trust, responsibility, and safely adopt AI (Amann et al., 2020; Chattopadhyay, Barman, and Lakshmi, 2025). The development of multimodal AI models that integrate imaging, genomic, laboratory, and clinical data will be beneficial in personalized medicine by making highly accurate and patient-specific predictions and treatment plans (Guan, 2019; Khalifa, Albadawy, and Iqbal, 2024). Moreover, AI-based systems of decision support will keep evolving and will include real-time analytics, forecasting, and adaptive learning to support clinicians in demanding and rapidly evolving situations (Mohammadabadi et al., 2024; Loeb, 2021).

The other urgent direction is to respond to ethical, legal, and equity-related issues related to the deployment of AI. To ensure their sustainable and responsible use, it will be necessary to ensure strong data privacy, the elimination of bias, and fair access to AI technologies (Al Sulaiman et al., 2025; Koonrungsesomboon, Laothavorn, and Karbwang, 2016). The subsequent studies shall deal with creating governing principles, uniform guidelines, and multi-disciplinary cooperation among healthcare professionals, information scientists, and ethicists and policymakers, so that artificial intelligence does not hinder the provision of healthcare, but promotes it (Thammasitboon and Cutrer, 2013; Pietilae et al., 2019). With technical innovation and strict ethical and regulatory protection, AI can help to turn the healthcare system into a more specific, effective, and patient-centered system.

Conclusion

Artificial Intelligence is already transforming the healthcare industry by improving the accuracy of diagnosis, minimizing human error, and assisting with informed clinical decision-making. AI can be used in medical practice to detect the disease at an early stage, plan treatment individually and improve patient outcomes by combining imaging, genomic, and clinical data. Meanwhile, ethical aspects, such as the privacy of data, the transparency of algorithms and the necessity to retain clinician control over AI, are essential aspects of responsible AI implementation. In the future, explainable, adaptive, and equitable AI systems, coupled with a strong governance system and interdisciplinary work, will be necessary to best achieve the benefits of AI and reduce its risks. Overall, AI can help to make the healthcare system more accurate, efficient, and patient-centered, which will improve the quality and accessibility of medical services.

References:

1. Abimanyi-Ochom, J., Bohingamu Mudiyanselage, S., Catchpool, M., Firipis, M., Wanni Arachchige Dona, S., & Watts, J. J. (2019). Strategies to reduce diagnostic errors: a systematic review. *BMC medical informatics and decision making*, *19*(1), 174.

2. Al Sulaiman, K., Alharthi, A. F., Alqahtani, R., Aljouie, A., Khan, A., Al-jedai, A., ... & Aljuhani, O. (2025). Ethical, data security, and resource allocation considerations in AI integration for healthcare during Hajj: task force insights and future directions. *International Journal of Medical Informatics*, 106123.

3. Amann, J., Blasimme, A., Vayena, E., Frey, D., Madai, V. I., & Precise4Q Consortium. (2020). Explainability for artificial intelligence in healthcare: a multidisciplinary perspective. *BMC medical informatics and decision making*, *20*(1), 310.

4. Castaneda, C., Nalley, K., Mannion, C., Bhattacharyya, P., Blake, P., Pecora, A., ... & Suh, K. S. (2015). Clinical decision support systems for improving diagnostic accuracy and achieving precision medicine. *Journal of clinical bioinformatics*, *5*(1), 4.

5. Chattopadhyay, S., Barman, S., & Lakshmi, D. (2025). The Role of Explainable AI for Healthcare 5.0: Best Practices, Challenges, and Opportunities. *Edge AI for Industry 5.0 and Healthcare 5.0 Applications*, 45-80.

6. Degnan, A. J., Ghobadi, E. H., Hardy, P., Krupinski, E., Scali, E. P., Stratchko, L., ... & Auffermann, W. F. (2019). Perceptual and interpretive error in diagnostic radiology—causes and potential solutions. *Academic radiology*, *26*(6), 833-845.

7. Dias, R., & Torkamani, A. (2019). Artificial intelligence in clinical and genomic diagnostics. *Genome medicine*, *11*(1), 70.

8. Elkin, P. L., Liebow, M., Bauer, B. A., Chaliki, S., Wahner-Roedler, D., Bundrick, J., ... & Barnett, G. O. (2010). The introduction of a diagnostic decision support system (DXplain™) into the workflow of a teaching hospital service can decrease the cost of service for diagnostically challenging Diagnostic Related Groups (DRGs). *International journal of medical informatics*, *79*(11), 772-777.

9. Ghaffar Nia, N., Kaplanoglu, E., & Nasab, A. (2023). Evaluation of artificial intelligence techniques in disease diagnosis and prediction. *Discover Artificial Intelligence*, *3*(1), 5.

10. Guan, J. (2019). Artificial intelligence in healthcare and medicine: promises, ethical challenges and

governance. *Chinese Medical Sciences Journal*, *34*(2), 76-83.

11. Khalifa, M., & Albadawy, M. (2024). AI in diagnostic imaging: revolutionising accuracy and efficiency. *Computer Methods and programs in biomedicine update*, *5*, 100146.

12. Khalifa, M., Albadawy, M., & Iqbal, U. (2024). RETRACTED: Advancing clinical decision support: The role of artificial intelligence across six domains.

13. Koonrungsesomboon, N., Laothavorn, J., & Karbwang, J. (2016). Ethical considerations and challenges in first-in-human research. *Translational Research*, *177*, 6-18.

14. Li, X., Zhang, L., Yang, J., & Teng, F. (2024). Role of artificial intelligence in medical image analysis: A review of current trends and future directions. *Journal of Medical and Biological Engineering*, *44*(2), 231-243.

15. Loeb, G. E. (2021). A new approach to medical diagnostic decision support. *Journal of Biomedical Informatics*, *116*, 103723.

16. Mirbabaie, M., Stieglitz, S., & Frick, N. R. (2021). Artificial intelligence in disease diagnostics: A critical review and classification on the current state of research guiding future direction. *Health and Technology*, *11*(4), 693-731.

17. Mohammadabadi, S. M. S., Seyedkhamoushi, F., Mostafavi, M., & Peikani, M. B. (2024). Examination of AI's role in Diagnosis, Treatment, and Patient care. In *Transforming gender-based healthcare with AI and machine learning* (pp. 221-238). CRC Press.

18. Nazir, A., Hussain, A., Singh, M., & Assad, A. (2025). Deep learning in medicine: advancing healthcare with intelligent solutions and the future of holography imaging in early diagnosis. *Multimedia Tools and Applications*, *84*(17), 17677-17740.

19. Nichols, J. A., Herbert Chan, H. W., & Baker, M. A. (2019). Machine learning: applications of artificial intelligence to imaging and diagnosis. *Biophysical reviews*, *11*(1), 111-118.

20. Pietilä, A. M., Nurmi, S. M., Halkoaho, A., & Kyngäs, H. (2019). Qualitative research: Ethical considerations. In *The application of content analysis in nursing science research* (pp. 49-69). Cham: Springer International Publishing.

21. Rai, H. M., Yoo, J., & Dashkevych, S. (2025). Transformative Advances in AI for Precise Cancer Detection: A Comprehensive Review of Non-

Invasive Techniques. *Archives of Computational Methods in Engineering*, 1-82.

22. Thammasitboon, S., & Cutrer, W. B. (2013). Diagnostic decision-making and strategies to improve diagnosis. *Current Problems in Pediatric and Adolescent Health Care*, *43*(9), 232-241.

23. Van Cott, H. (2018). Human errors: Their causes and reduction. In *Human error in medicine* (pp. 53-65). CRC Press.