Artificial Intelligence's Impact on Cancer Treatment: Advancements and Future Directions

ARTICLE INFO

Article Type

Review Article

Authors

AboTaleb Saremi[1,2], Bahareh Abbasi,[3*], Elham Karimi-MansoorAbad[1,2], Yasin Ashourian[1,2]

1- Sarem Gynecology, Obstetrics and Infertility Research Center, Sarem Women's Hospital, Iran University of Medical Science (IUMS), Tehran, Iran.

2- Sarem Cell Research Center (SCRC), Sarem Women's Hospital, Tehran, Iran.

Department of Medical Genetics, National Institute of Genetic Engineering and Biotechnology (NIGEB), Tehran, Iran.

***Corresponding Authors:**

Bahareh Abbasi1; MD, Department of Medical Genetics, National Institute of Genetic Engineering and Biotechnology (NIGEB), Tehran, Iran.

Email: b.abbasi@nigeb.ac.ir

Received: 14 November 2023

Accepted: 20 December, 2023

e Published: 3 August 2024

Article History

ABSTRACT

This narrative review explores the transformative impact of artificial intelligence (AI) on cancer treatment, encompassing early detection, medical imaging, personalized treatment plans, radiotherapy, surgery, clinical decision support systems, and future directions. AI has revolutionized early cancer detection by enhancing the accuracy and accessibility of diagnostics through medical imaging, histopathological analysis, and genetic data interpretation. In medical imaging, AI improves diagnosis precision and accelerates the identification of abnormalities. Personalized treatment plans, guided by AI-driven insights, optimize therapy while minimizing side effects. AI expedites drug discovery, enhances radiotherapy, and enables precise surgical interventions. Clinical Decision Support Systems aid in data interpretation and treatment planning. The future promises predictive analytics, AI-driven drug development, robotic surgery, and integrated EHRs. Ethical considerations include data privacy and algorithmic bias. AI's integration into cancer care marks a paradigm shift toward innovative, patient-centric, and effective treatment strategies.

Keywords: artificial intelligence, cancer treatment, early detection, medical imaging, personalized treatment, radiotherapy, surgery

Introduction

In recent years, the field of healthcare has witnessed a transformative revolution, with artificial intelligence (AI) emerging as a powerful tool that holds immense promise in the realm of cancer treatment. Cancer, a complex and devastating disease that affects millions of lives worldwide, has long been a challenge for both medical professionals and researchers. The intricacies of cancer biology, the variability in patient responses, and the need for personalized treatment plans have made it a prime candidate for the integration of AI-driven solutions. This narrative review aims to delve into the multifaceted impact of AI on the landscape of cancer treatment, from early detection and accurate diagnosis to personalized therapeutic strategies and clinical decision support. By examining the latest advancements, challenges, and ethical considerations, we endeavor to provide a comprehensive overview of how AI is shaping the future of cancer care. As we embark on this exploration, it becomes evident that AI is not merely a tool but a catalyst for innovation, one that has the potential to revolutionize the way we understand, diagnose, and treat cancer (1-3).

AI in Early Cancer Detection

Artificial Intelligence (AI) has emerged as a transformative force in the field of healthcare, particularly in the early detection of cancer. Early detection of cancer plays a crucial role in improving patient outcomes and survival rates. AI technologies have demonstrated remarkable capabilities in aiding healthcare professionals in this critical aspect of cancer care (4, 5).

One of the primary applications of AI in early cancer detection is in medical imaging. AI algorithms, particularly deep learning models, have shown extraordinary proficiency in interpreting medical images such as X-rays, mammograms, CT scans, and MRIs. These algorithms can identify subtle abnormalities, even at a microscopic level, which might be challenging for the human eye to discern. For example, AI-powered mammography systems can analyze mammograms to detect breast tumors at their earliest stages (6, 7).

In addition to improving accuracy and efficiency, AI also holds promise in making early cancer detection more accessible. Telemedicine platforms equipped with AI can extend diagnostic capabilities to underserved regions, where access to expert healthcare professionals is limited. Patients in remote areas can upload their medical images and receive rapid AI-assisted diagnoses, potentially saving valuable time in the early stages of cancer (13-15).

Despite these remarkable advancements, challenges remain. The integration of AI into clinical workflows requires careful validation, regulatory compliance, and addressing ethical concerns. Ensuring data privacy and mitigating biases in AI algorithms are critical considerations in the implementation of AI for early cancer detection (16-18).

AI has revolutionized the landscape of early cancer detection by enhancing the accuracy, speed, and accessibility of diagnostic processes. It complements the expertise of healthcare professionals and holds immense potential in improving cancer outcomes. As AI technologies continue to evolve, they will undoubtedly play an increasingly vital role in the early detection and management of cancer, ultimately benefiting patients worldwide (19-21).

AI in Medical Imaging and Radiology

AI has emerged as a transformative force in the field of medical imaging and radiology, revolutionizing the way we detect, diagnose, and monitor various diseases, including cancer. In particular, the application of artificial intelligence (AI) in medical imaging has ushered in a new era of accuracy and efficiency, offering healthcare professionals powerful tools to improve patient outcomes (22-25).

One of the most significant contributions of AI in medical imaging is its role in enhancing the accuracy of cancer diagnosis. Traditionally, radiologists relied on their expertise to interpret complex images from modalities such as X-rays, MRIs, and CT scans. However, AI algorithms can now assist in this process by identifying subtle patterns and anomalies that might escape the human eye. This has led to earlier and more precise cancer diagnoses, a critical factor in improving treatment success rates (26-32).

AI's ability to analyze vast amounts of imaging data quickly is another major advantage. In a matter of seconds, AI algorithms can process and analyze hundreds of images, making it possible to detect abnormalities, track disease progression, and assess treatment effectiveness in real-time. This speed and accuracy not only save valuable time but also reduce the risk of human error (33-35).

Furthermore, AI has opened the door to more personalized cancer treatment plans. By integrating patient-specific data, such as genetics, medical history, and imaging results, AI algorithms can recommend tailored treatment approaches. This level of personalization can optimize treatment outcomes while minimizing side effects, as therapies are aligned with an individual's unique characteristics and needs (36-38).

In the realm of cancer research, AI-driven innovations have expedited drug discovery and development.

Machine learning algorithms can analyze vast biological datasets, identifying potential drug candidates and predicting their effectiveness against specific cancer types. This has the potential to significantly shorten the timeline for bringing new cancer drugs to market, offering hope to patients with limited treatment options (36-40).

Beyond diagnosis and drug development, AI is also enhancing the precision of radiation therapy and surgical procedures. In radiation therapy, AI can assist in treatment planning, optimizing the radiation (41, 42).

AI algorithms enable surgeons to perform intricate and minimally invasive procedures with unprecedented precision (43, 44).

Despite the remarkable progress in AI applications in medical imaging and radiology, challenges remain. Data privacy concerns, potential bias in algorithms, and regulatory hurdles must be addressed to ensure the responsible and ethical use of AI in healthcare. Nevertheless, the potential benefits of AI in cancer diagnosis and treatment are undeniable, and ongoing research and innovation continue to push the boundaries of what is possible in the fight against cancer (45-47).

Personalized Treatment Plans with AI

Personalized treatment plans in cancer care have witnessed a transformative shift with the integration of artificial intelligence (AI). Traditional approaches to cancer treatment often relied on one-size-fits-all strategies, but AI has revolutionized this paradigm by tailoring treatment regimens to individual patients. This personalized approach has the potential to significantly improve patient outcomes and enhance the overall effectiveness of cancer therapies (48-51).

AI-driven personalized treatment plans start by harnessing a wealth of patient-specific data. This data includes a patient's medical history, genomic information, imaging results, and even lifestyle factors. Machine learning algorithms are then employed to analyze and interpret this multifaceted data, identifying unique patterns and biomarkers that can inform treatment decisions (52-54).

One of the key advantages of AI in personalized cancer treatment is its ability to identify specific genetic mutations and alterations within a patient's tumor. By understanding the genetic profile of the cancer, AI can recommend targeted therapies that are more likely to be effective. This not only improves the chances of successful treatment but also minimizes unnecessary exposure to treatments that may have limited benefit (55, 56).

Furthermore, AI can continuously monitor a patient's response to treatment, making real-time adjustments to the personalized treatment plan. This dynamic approach allows for the early detection of treatment resistance or adverse effects, enabling oncologists to modify the regimen promptly. This level of adaptability can be crucial in optimizing treatment outcomes and minimizing side effects (57-59).

AI also plays a pivotal role in predicting patient prognosis. By analyzing historical patient data and treatment outcomes, AI algorithms can provide oncologists with valuable insights into a patient's likely response to a particular treatment. This prognostic information aids in decision-making, allowing clinicians to choose the most appropriate and effective therapies for individual patients (60, 61).

The integration of AI in personalized cancer treatment plans is not without its challenges. Data privacy and security issues must be addressed to protect sensitive patient information. Additionally, the potential for algorithmic bias and the need for robust validation of AI-driven recommendations are ongoing concerns in the field (62-65).

AI has ushered in a new era of personalized cancer treatment plans. By harnessing the power of data-driven insights and machine learning, AI empowers oncologists to tailor treatments to the unique characteristics of each patient's cancer. This approach holds the promise of improving treatment outcomes, reducing adverse effects, and ultimately advancing the field of oncology towards more effective and individualized care. As technology continues to evolve, the integration of AI in cancer treatment planning is likely to become increasingly sophisticated, offering new hope for patients in their battle against cancer (62-65).

Enhancing Radiotherapy and Surgery

Enhancing Radiotherapy and Surgery in the realm of cancer treatment has been greatly influenced by the integration of Artificial Intelligence (AI) technologies. These innovative advancements have ushered in a new era of precision and efficiency, ultimately benefiting both patients and healthcare professionals (66-69).

In the field of radiotherapy, AI has played a pivotal role in optimizing treatment plans. By analyzing vast datasets of patient information, AI algorithms can tailor radiation therapy regimens to individual cases, ensuring that the maximum therapeutic effect is achieved while minimizing damage to surrounding healthy tissues. This level of personalization not only enhances treatment outcomes but also reduces the potential for debilitating side effects, improving the overall quality of life for cancer patients (70, 71).

Furthermore, AI has revolutionized the planning and delivery of radiation therapy. Machine learning algorithms can quickly process complex imaging data to identify the exact location and shape of tumors. This precision enables clinicians to target cancerous tissues with unparalleled accuracy, sparing nearby organs and tissues. The result is a more effective and less invasive treatment process (72-74).

In the realm of surgery, AI-driven technologies have empowered surgeons with valuable tools and insights. Robotic surgical systems, guided by AI algorithms, can perform intricate procedures with unparalleled precision. Surgeons can remotely control robotic arms, which are capable of executing delicate maneuvers that might be challenging for human hands alone. This level of precision minimizes the risk of complications during surgery and reduces recovery times for patients (75-77).

Moreover, AI assists in surgical planning by analyzing preoperative imaging data. It can generate 3D models of a patient's anatomy, allowing surgeons to simulate procedures and identify potential challenges before entering the operating room. This preoperative planning reduces the margin of error and enhances the overall safety of surgical interventions (78-80).

In both radiotherapy and surgery, the real-time capabilities of AI are transformative. During procedures, AI can analyze live data feeds, offering critical insights to healthcare professionals. For example, in surgery, AI can alert surgeons to anomalies or provide guidance on the best course of action based on real-time data analysis. In radiotherapy, AI can adjust treatment plans on the fly, accounting for any unexpected changes in a patient's condition or tumor size (78-80).

While the integration of AI in radiotherapy and surgery offers numerous benefits, challenges and ethical considerations must also be acknowledged. Issues related to data privacy, bias in algorithms, and the need for ongoing training of healthcare professionals in AI technologies require careful attention (81-83).

AI has significantly enhanced the fields of radiotherapy and surgery in the treatment of cancer. Its ability to personalize treatment plans, improve precision, and offer real-time insights has transformed the landscape of cancer care. As technology continues to advance, AI will undoubtedly play an increasingly vital role in the fight against cancer, offering new hope to patients and revolutionizing the way cancer is treated (84-86).

Clinical Decision Support Systems

Clinical Decision Support Systems (CDSS) have emerged as powerful tools in modern healthcare, particularly in the context of cancer treatment. These systems leverage artificial intelligence (AI) and data-driven algorithms to assist healthcare providers in making informed decisions about patient care. The integration of CDSS into clinical practice has brought about significant advancements in cancer diagnosis and treatment (87-89).

One of the primary roles of CDSS in oncology is aiding in the interpretation of complex patient data. These systems can process vast amounts of clinical and genomic data, enabling oncologists to identify patterns and correlations that may not be apparent through traditional methods. For instance, CDSS can analyze genetic mutations in a patient's tumor and recommend targeted therapies that are more likely to be effective, thereby increasing treatment precision (90, 91).

Furthermore, CDSS contributes to the optimization of treatment plans. In cancer treatment, decisions about radiation therapy and chemotherapy are critical. CDSS can assist in tailoring treatment regimens based on a patient's unique characteristics, such as age, genetics, and overall health. This personalized approach not only improves treatment outcomes but also minimizes side effects, enhancing the quality of life for cancer patients (92).

CDSS also plays a vital role in the early detection of treatment-related complications. By continuously monitoring patient data and clinical parameters, these systems can promptly alert healthcare providers to potential issues. This proactive approach enables timely interventions and reduces the risk of adverse events during cancer treatment (93, 94).

Moreover, the integration of CDSS with electronic health records (EHRs) streamlines the decision-making process. Oncologists can access patient data, treatment histories, and recommendations from a centralized platform, facilitating collaborative care and reducing the likelihood of errors (95).

While CDSS holds immense promise, several challenges must be addressed. Data privacy and security concerns are paramount, given the sensitive nature of patient information. Additionally, ensuring the accuracy and fairness of AI algorithms is essential to prevent bias and promote equitable cancer care (96-99).

Overall, Clinical Decision Support Systems are transforming the landscape of cancer treatment. These AI-driven tools enhance diagnosis accuracy, personalize treatment plans, and improve patient outcomes. As technology continues to advance, the integration of CDSS with clinical practice will likely become even more pervasive, further revolutionizing cancer care and underscoring the importance of data-driven decision support in modern medicine (100-102).

Future Directions and Innovations

As we delve into the future of cancer treatment, it becomes increasingly evident that artificial intelligence (AI) is poised to play a pivotal role in transforming the landscape of oncology. The innovations and directions in which AI is heading promise to usher in a new era of personalized, precise, and effective cancer care (103-105).

One of the most promising areas of future development lies in the realm of predictive analytics. AI algorithms are evolving to not only detect cancer but also to forecast its behavior and response to treatment. By analyzing vast datasets comprising genomic, clinical, and imaging information, AI can provide oncologists with predictive insights. These insights include the likelihood of disease progression, potential treatment responses, and the identification of patients who may benefit from targeted therapies. Such predictive capabilities will enable healthcare providers to tailor treatment plans to individual patients with unprecedented accuracy (106-108).

Furthermore, AI is expected to revolutionize cancer drug discovery and development. Traditional drug discovery is a time-consuming and costly process. AI-driven platforms can significantly expedite this process by sifting through vast chemical libraries, predicting the effectiveness of compounds, and identifying novel drug candidates. This not only accelerates the arrival of new cancer therapies but also opens doors to innovative treatments that were previously overlooked (109-111).

In the operating room, AI-guided robotic surgeries are on the horizon. Surgeons will have access to real-time, AI-driven assistance during cancer surgeries. These systems can enhance precision, reduce the risk of complications, and even enable minimally invasive procedures that were once deemed too complex. This innovation will ultimately lead to improved outcomes for cancer patients undergoing surgery (112-114).

Another noteworthy direction is the integration of AI with electronic health records (EHRs) and clinical decision support systems. AI will seamlessly analyze patient data, match it with the latest research findings, and provide clinicians with treatment recommendations in real time. This integration will not only enhance the speed and accuracy of decision-making but also ensure that treatment plans align with the most up-to-date medical knowledge (115-118).

However, it's essential to acknowledge the ethical considerations that accompany these innovations. Patient data privacy, algorithmic bias, and the need for regulatory oversight are crucial issues that must be addressed as AI takes center stage in cancer care. The responsible and ethical deployment of AI technologies remains a priority (119-121).

To sum up, the future directions and innovations in AI-driven cancer treatment are filled with promise. From predictive analytics to drug discovery, surgical assistance, and clinical decision support, AI is poised to redefine how we approach and combat cancer. With responsible implementation and continuous research, AI stands as a powerful ally in the fight against one of humanity's most formidable adversaries. As we look forward, it is clear that the fusion of AI and oncology holds the potential to save lives and improve the quality of life for countless individuals affected by cancer (122-125).

Conclusion

In conclusion, the integration of artificial intelligence (AI) into cancer treatment represents a profound shift towards innovation and precision. Throughout this narrative review, AI's multifaceted applications in cancer care, spanning early detection, personalized treatment planning, and drug development, have showcased its remarkable potential and tangible clinical benefits. AI excels in early cancer detection, enhancing the identification of lesions at treatable stages and improving patient outcomes. It has revolutionized medical imaging and radiology by automating tasks and aiding in accurate diagnosis. Personalized treatment plans, driven by AI's analysis of big data and genomics, optimize therapies while minimizing side effects. Additionally, AI expedites drug discovery and augments radiotherapy and surgical precision. Despite challenges related to privacy, bias, and ethics, the future holds great promise with emerging trends like explainable AI and federated learning. Collaboration between researchers and healthcare professionals is vital to harness AI's transformative potential and improve cancer care, marking a pivotal advancement in the fight against cancer.

Ethical Issue

There was no ethical issue in this review.

Conflict of Interests

There was no conflict of interest in this study.

Source of Funding

This study has been financially supported by Sarem Gynecology, Obstetrics and Infertility Research Center, Sarem Women's Hospital

Author's ORCID

AboTaleb Saremi
http://orcid.org/0000-0003-4191-6624

Reference:

1. Yazdian Anari P, Zahergivar A, Gopal N, Chaurasia A, Lay N, Ball MW, et al. Kidney scoring surveillance: predictive machine learning models for clear cell renal cell carcinoma growth using MRI. Abdom Radiol (NY). 2024.

2. Ko J, Hyung S, Cheong S, Chung Y, Li Jeon N. Revealing the clinical potential of high-resolution organoids. Adv Drug Deliv Rev. 2024;207:115202.

3. Li J, Xiang Y, Han J, Gao Y, Wang R, Dong Z, et al. Retinopathy as a predictive indicator for significant hepatic fibrosis according to T2DM status: A cross-sectional study based on the National Health

and Nutrition Examination Survey Data. Ann Hepatol. 2024:101478.

4. Takahashi N, Takano Y, Takeshita K, Toya N, Yano F, Eto K. Proctoring System Enables Safe Induction of Robotic Gastrectomy: Short-term Outcomes of the First 10 Cases. Anticancer Res. 2024;44(2):823-8.

5. Bhattacharya A, Pal M. Prediction on nature of cancer by fuzzy graphoidal covering number using artificial neural network. Artif Intell Med. 2024;148:102783.

6. Jin W, Fatehi M, Guo R, Hamarneh G. Evaluating the clinical utility of artificial intelligence assistance and its explanation on the glioma grading task. Artif Intell Med. 2024;148:102751.

7. Liu H, Huang J, Li Q, Guan X, Tseng M. A deep convolutional neural network for the automatic segmentation of glioblastoma brain tumor: Joint spatial pyramid module and attention mechanism network. Artif Intell Med. 2024;148:102776.

8. Matin HN, Setayeshi S. A computational tumor growth model experience based on molecular dynamics point of view using deep cellular automata. Artif Intell Med. 2024;148:102752.

9. Nopour R. Screening ovarian cancer by using risk factors: machine learning assists. Biomed Eng Online. 2024;23(1):18.

10. Fein JA, Patel SS. Under AI's lens: spotting mutations visually. Blood Adv. 2024;8(3):827-8.

11. Unger M, Kather JN. A systematic analysis of deep learning in genomics and histopathology for precision oncology. BMC Med Genomics. 2024;17(1):48.

12. Ren J, Yang G, Song Y, Zhang C, Yuan Y. Machine learning-based MRI radiomics for assessing the level of tumor infiltrating lymphocytes in oral tongue squamous cell carcinoma: a pilot study. BMC Med Imaging. 2024;24(1):33.

13. Warin K, Suebnukarn S. Deep learning in oral cancer- a systematic review. BMC Oral Health. 2024;24(1):212.

14. Zhao Q, Wang M, Chen M. Tumor polo-like kinase 4 protein expression reflects lymphovascular invasion, higher Federation of Gynecology and Obstetrics stage, and shortened survival in endometrial cancer patients who undergo surgical resection. BMC Womens Health. 2024;24(1):101.

15. Gurmessa DK, Jimma W. Explainable machine learning for breast cancer diagnosis from mammography and ultrasound images: a systematic review. BMJ Health Care Inform. 2024;31(1).

16. Benzaquen J, Hofman P, Lopez S, Leroy S, Rouis N, Padovani B, et al. Integrating artificial intelligence into lung cancer screening: a randomised controlled trial protocol. BMJ Open. 2024;14(2):e074680.

17. Viberg Johansson J, Dembrower K, Strand F, Grauman Å. Women's perceptions and attitudes towards the use of AI in mammography in Sweden: a qualitative interview study. BMJ Open. 2024;14(2):e084014.

18. Usuzaki T, Takahashi K, Inamori R. Letter to the editor on "Automated classification of fat-infiltrated axillary lymph nodes on screening mammograms". Br J Radiol. 2024;97(1154):479-80.

19. Santeramo R, Damiani C, Wei J, Montana G, Brentnall AR. Are better AI algorithms for breast cancer detection also better at predicting risk? A paired case-control study. Breast Cancer Res. 2024;26(1):25.

20. Chuwdhury GS, Guo Y, Chiang CL, Lam KO, Kam NW, Liu Z, Dai W. ImmuneMirror: A machine learning-based integrative pipeline and web server for neoantigen prediction. Brief Bioinform. 2024;25(2).

21. Fang M, Fang J, Luo S, Liu K, Yu Q, Yang J, et al. eccDNA-pipe: an integrated pipeline for identification, analysis and visualization of extrachromosomal circular DNA from high-throughput sequencing data. Brief Bioinform. 2024;25(2).

22. Guo LX, Wang L, You ZH, Yu CQ, Hu ML, Zhao BW, Li Y. Likelihood-based feature representation learning combined with neighborhood information for predicting circRNA-miRNA associations. Brief Bioinform. 2024;25(2).

23. Guo Y, Hu H, Chen W, Yin H, Wu J, Hsieh CY, et al. SynergyX: a multi-modality mutual attention network for interpretable drug synergy prediction. Brief Bioinform. 2024;25(2).

24. Wei Q, Islam MT, Zhou Y, Xing L. Self-supervised deep learning of gene-gene interactions for improved gene expression recovery. Brief Bioinform. 2024;25(2).

25. Guerra A, Orton MR, Wang H, Konidari M, Maes K, Papanikolaou NK, Koh DM. Clinical application of machine learning models in patients

with prostate cancer before prostatectomy. Cancer Imaging. 2024;24(1):24.

26. Hu C, Qiao X, Hu C, Cao C, Wang X, Bao J. The practical clinical role of machine learning models with different algorithms in predicting prostate cancer local recurrence after radical prostatectomy. Cancer Imaging. 2024;24(1):23.

27. Kang Z, Zhao YX, Qiu RSQ, Chen DN, Zheng QS, Xue XY, et al. Identification macrophage signatures in prostate cancer by single-cell sequencing and machine learning. Cancer Immunol Immunother. 2024;73(3):41.

28. Yoshikawa AL, Omura T, Takahashi-Kanemitsu A, Susaki EA. Blueprints from plane to space: outlook of next-generation three-dimensional histopathology. Cancer Sci. 2024.

29. Foltz EA, Witkowski A, Becker AL, Latour E, Lim JY, Hamilton A, Ludzik J. Artificial Intelligence Applied to Non-Invasive Imaging Modalities in Identification of Nonmelanoma Skin Cancer: A Systematic Review. Cancers (Basel). 2024;16(3).

30. Bao X, Li Q, Chen D, Dai X, Liu C, Tian W, et al. A multiomics analysis-assisted deep learning model identifies a macrophage-oriented module as a potential therapeutic target in colorectal cancer. Cell Rep Med. 2024:101399.

31. Karas S, Mathijssen RHJ, van Schaik RHN, Forrest A, Wiltshire T, Bies RR, Innocenti F. Model-Based Prediction of Irinotecan-Induced Grade 4 Neutropenia in Cancer Patients: Influence of Incorporating Germline Genetic Factors in the Model. Clin Pharmacol Ther. 2024.

32. Maniaci A, Saibene AM, Calvo-Henriquez C, Vaira L, Radulesco T, Michel J, et al. Is generative pre-trained transformer artificial intelligence (Chat-GPT) a reliable tool for guidelines synthesis? A preliminary evaluation for biologic CRSwNP therapy. Eur Arch Otorhinolaryngol. 2024.

33. Echecopar C, Abad I, Galán-Gómez V, Mozo Del Castillo Y, Sisinni L, Bueno D, et al. An artificial intelligence-driven predictive model for pediatric allogeneic hematopoietic stem cell transplantation using clinical variables. Eur J Haematol. 2024.

34. Yousefirizi F, Klyuzhin IS, O JH, Harsini S, Tie X, Shiri I, et al. TMTV-Net: fully automated total metabolic tumor volume segmentation in lymphoma PET/CT images - a multi-center generalizability analysis. Eur J Nucl Med Mol Imaging. 2024.

35. O'Connor S, Vercell A, Wong D, Yorke J, Fallatah FA, Cave L, Anny Chen LY. The application and use of artificial intelligence in cancer nursing: A systematic review. Eur J Oncol Nurs. 2024;68:102510.

36. Levin G, Matanes E, Brezinov Y, Ferenczy A, Pelmus M, Brodeur MN, et al. Machine learning for prediction of concurrent endometrial carcinoma in patients diagnosed with endometrial intraepithelial neoplasia. Eur J Surg Oncol. 2024;50(3):108006.

37. Padhani AR, Godtman RA, Schoots IG. Key learning on the promise and limitations of MRI in prostate cancer screening. Eur Radiol. 2024.

38. Bereska JI, Janssen BV, Nio CY, Kop MPM, Kazemier G, Busch OR, et al. Artificial intelligence for assessment of vascular involvement and tumor resectability on CT in patients with pancreatic cancer. Eur Radiol Exp. 2024;8(1):18.

39. Gitto S, Serpi F, Albano D, Risoleo G, Fusco S, Messina C, Sconfienza LM. AI applications in musculoskeletal imaging: a narrative review. Eur Radiol Exp. 2024;8(1):22.

40. Tayebi Arasteh S, Misera L, Kather JN, Truhn D, Nebelung S. Enhancing diagnostic deep learning via self-supervised pretraining on large-scale, unlabeled non-medical images. Eur Radiol Exp. 2024;8(1):10.

41. Peng Y, Wang Y, Wen Z, Xiang H, Guo L, Su L, et al. Deep learning and machine learning predictive models for neurological function after interventional embolization of intracranial aneurysms. Front Neurol. 2024;15:1321923.

42. Liu R, Gong G, Meng K, Du S, Yin Y. Hippocampal sparing in whole-brain radiotherapy for brain metastases: controversy, technology and the future. Front Oncol. 2024;14:1342669.

43. Chen C, Xie Z, Ni Y, He Y. Screening immune-related blood biomarkers for DKD-related HCC using machine learning. Front Immunol. 2024;15:1339373.

44. Zhang B, Zhang W, Yao H, Qiao J, Zhang H, Song Y. A study on the improvement in the ability of endoscopists to diagnose gastric neoplasms using an artificial intelligence system. Front Med (Lausanne). 2024;11:1323516.

45. Gencer A. Bibliometric analysis and research trends of artificial intelligence in lung cancer. Heliyon. 2024;10(2):e24665.

46. Ojewunmi OO, Adeyemo TA, Oyetunji AI, Inyang B, Akinrindoye A, Mkumbe BS, et al. The genetic dissection of fetal haemoglobin persistence in sickle cell disease in Nigeria. Hum Mol Genet. 2024.

47. Tang L, Zhang W, Zhang Y, Deng W, Zhao M. Machine Learning-Based Integrated Analysis of PANoptosis Patterns in Acute Myeloid Leukemia Reveals a Signature Predicting Survival and Immunotherapy. Int J Clin Pract. 2024;2024:5113990.

48. Mevik K, Zebene Woldaregay A, Ringdal A, Øyvind Mikalsen K, Xu Y. Exploring surgical infection prediction: A comparative study of established risk indexes and a novel model. Int J Med Inform. 2024;184:105370.

49. Behara K, Bhero E, Agee JT. Grid-Based Structural and Dimensional Skin Cancer Classification with Self-Featured Optimized Explainable Deep Convolutional Neural Networks. Int J Mol Sci. 2024;25(3).

50. Yonezawa S, Haruki T, Koizumi K, Taketani A, Oshima Y, Oku M, et al. Establishing Monoclonal Gammopathy of Undetermined Significance as an Independent Pre-Disease State of Multiple Myeloma Using Raman Spectroscopy, Dynamical Network Biomarker Theory, and Energy Landscape Analysis. Int J Mol Sci. 2024;25(3).

51. Zhang YF, Zhou C, Guo S, Wang C, Yang J, Yang ZJ, et al. Deep learning algorithm-based multimodal MRI radiomics and pathomics data improve prediction of bone metastases in primary prostate cancer. J Cancer Res Clin Oncol. 2024;150(2):78.

52. Qureshi MA. Integration of Next Generation Sequencing, Artificial Intelligence and Machine Learning in Cancer Diagnostics: A Major Leap Forward. J Coll Physicians Surg Pak. 2024;34(2):127-8.

53. Munir MM, Endo Y, Ejaz A, Dillhoff M, Cloyd JM, Pawlik TM. Online artificial intelligence platforms and their applicability to gastrointestinal surgical operations. J Gastrointest Surg. 2024;28(1):64-9.

54. Lin YH, Lin CT, Chang YH, Lin YY, Chen JJ, Huang CR, et al. Development and Validation of a 3D Resnet Model for Prediction of Lymph Node Metastasis in Head and Neck Cancer Patients. J Imaging Inform Med. 2024.

55. Salehi MA, Mohammadi S, Harandi H, Zakavi SS, Jahanshahi A, Shahrabi Farahani M, Wu JS. Diagnostic Performance of Artificial Intelligence in Detection of Primary Malignant Bone Tumors: a Meta-Analysis. J Imaging Inform Med. 2024.docrinology. 2021;19:1-6.

56. Shen J, Choi YL, Lee T, Kim H, Chae YK, Dulken BW, et al. Inflamed immune phenotype predicts favorable clinical outcomes of immune checkpoint inhibitor therapy across multiple cancer types. J Immunother Cancer. 2024;12(2).

57. Takeshita Y, Onozawa S, Katase S, Shirakawa Y, Yamashita K, Shudo J, et al. Evaluation of an artificial intelligence U-net algorithm for pulmonary nodule tracking on chest computed tomography images. J Int Med Res. 2024;52(2):3000605241230033.

58. Haj-Hosseini N, Lindblad J, Hasséus B, Kumar VV, Subramaniam N, Hirsch JM. Early Detection of Oral Potentially Malignant Disorders: A Review on Prospective Screening Methods with Regard to Global Challenges. J Maxillofac Oral Surg. 2024;23(1):23-32.

59. Li W, Zhang Y, Zhou X, Quan X, Chen B, Hou X, et al. Ensemble learning-assisted prediction of prolonged hospital length of stay after spine correction surgery: a multi-center cohort study. J Orthop Surg Res. 2024;19(1):112.

60. Read MD, Torikashvili J, Janjua H, Grimsley EA, Kuo PC, Docimo S. The downtrending cost of robotic bariatric surgery: a cost analysis of 47,788 bariatric patients. J Robot Surg. 2024;18(1):63.

61. Feng X, Shu W, Li M, Li J, Xu J, He M. Pathogenomics for accurate diagnosis, treatment, prognosis of oncology: a cutting edge overview. J Transl Med. 2024;22(1):131.

62. Gill IS, Desai MM, Cacciamani GE, Khandekar A, Parekh DJ. Robotic Radical Cystectomy for Bladder Cancer: The Way Forward. J Urol. 2024;211(3):476-80.

63. Haggenmüller S, Schmitt M, Krieghoff-Henning E, Hekler A, Maron RC, Wies C, et al. Federated Learning for Decentralized Artificial Intelligence in Melanoma Diagnostics. JAMA Dermatol. 2024.

64. Pigat L, Geisler BP, Sheikhalishahi S, Sander J, Kaspar M, Schmutz M, et al. Predicting Hypoxia Using Machine Learning: Systematic Review. JMIR Med Inform. 2024;12:e50642.

65. Ma Y, Achiche S, Pomey MP, Paquette J, Adjtoutah N, Vicente S, et al. Adapting and Evaluating an AI-Based Chatbot Through Patient and Stakeholder Engagement to Provide Information for Different Health Conditions: Master Protocol for an Adaptive Platform Trial (the MARVIN Chatbots Study). JMIR Res Protoc. 2024;13:e54668.

66. Pan X, Wang P, Jia S, Wang Y, Liu Y, Zhang Y, Jiang C. Multi-contrast learning-guided lightweight few-shot learning scheme for predicting breast cancer molecular subtypes. Med Biol Eng Comput. 2024.

67. Mohammad EB, Ahmad M. A systematic evaluation of big data-driven colorectal cancer studies. Med Glas (Zenica). 2024;21(1):63-77.

68. Zhang L, Liu Z, Zhang L, Wu Z, Yu X, Holmes J, et al. [Not Available]. Med Phys. 2024.

69. Liu C, Liu Z, Holmes J, Zhang L, Zhang L, Ding Y, et al. Artificial general intelligence for radiation oncology. Meta Radiol. 2023;1(3).

70. Malara N, Coluccio ML, Grillo F, Ferrazzo T, Garo NC, Donato G, et al. Multicancer screening test based on the detection of circulating non haematological proliferating atypical cells. Mol Cancer. 2024;23(1):32.

71. Su J, Yang L, Sun Z, Zhan X. Personalized drug therapy: innovative concept guided with proteoformics. Mol Cell Proteomics. 2024:100737.

72. Spratt DE, Tang S, Sun Y, Huang HC, Chen E, Mohamad O, et al. Artificial Intelligence Predictive Model for Hormone Therapy Use in Prostate Cancer. NEJM Evid. 2023;2(8):EVIDoa2300023.

73. Iannantuono GM, Bracken-Clarke D, Karzai F, Choo-Wosoba H, Gulley JL, Floudas CS. Comparison of Large Language Models in Answering Immuno-Oncology Questions: A Cross-Sectional Study. Oncologist. 2024.

74. Shatalov PA, Falaleeva NA, Bykova EA, Korostin DO, Belova VA, Zabolotneva AA, et al. Genetic and therapeutic landscapes in cohort of pancreatic adenocarcinomas: next-generation sequencing and machine learning for full tumor exome analysis. Oncotarget. 2024;15:91-103.

75. Rietjens JAC, Griffioen I, Sierra-Pérez J, Sroczynski G, Siebert U, Buyx A, et al. Improving shared decision-making about cancer treatment through design-based data-driven decision-support tools and redesigning care paths: an overview of the 4D PICTURE project. Palliat Care Soc Pract. 2024;18:26323524231225249.

76. Khongwirotphan S, Oonsiri S, Kitpanit S, Prayongrat A, Kannarunimit D, Chakkabat C, et al. Multimodality radiomics for tumor prognosis in nasopharyngeal carcinoma. PLoS One. 2024;19(2):e0298111.

77. Svendsen SMS, Pedersen DC, Jensen BW, Aarestrup J, Mellemkjær L, Bjerregaard LG, Baker JL. Early life body size and puberty markers as predictors of breast cancer risk later in life: A neural network analysis. PLoS One. 2024;19(2):e0296835.

78. Tegtmeier RC, Kutyreff CJ, Smetanick JL, Hobbis D, Laughlin BS, Toesca DAS, et al. Custom-Trained Deep Learning-Based Auto-Segmentation for Male Pelvic Iterative CBCT on C-Arm Linear Accelerators. Pract Radiat Oncol. 2024.

79. Xia W, Li D, He W, Pickhardt PJ, Jian J, Zhang R, et al. Multicenter Evaluation of a Weakly Supervised Deep Learning Model for Lymph Node Diagnosis in Rectal Cancer on MRI. Radiol Artif Intell. 2024:e230152.

80. Granata V, Fusco R, Coluccino S, Russo C, Grassi F, Tortora F, et al. Preliminary data on artificial intelligence tool in magnetic resonance imaging assessment of degenerative pathologies of lumbar spine. Radiol Med. 2024.

81. Auer TA, Müller L, Schulze D, Anhamm M, Bettinger D, Steinle V, et al. CT-guided High-Dose-Rate Brachytherapy versus Transarterial Chemoembolization in Patients with Unresectable Hepatocellular Carcinoma. Radiology. 2024;310(2):e232044.

82. Wamelink I, Azizova A, Booth TC, Mutsaerts H, Ogunleye A, Mankad K, et al. Brain Tumor Imaging without Gadolinium-based Contrast Agents: Feasible or Fantasy? Radiology. 2024;310(2):e230793.

83. Whybra P, Zwanenburg A, Andrearczyk V, Schaer R, Apte AP, Ayotte A, et al. The Image Biomarker Standardization Initiative: Standardized Convolutional Filters for Reproducible Radiomics and Enhanced Clinical Insights. Radiology. 2024;310(2):e231319.

84. Chang CL, Lin KC, Chen WM, Shia BC, Wu SY. Correspondence: Comprehensive insights on the underlying potential and advantage of proton therapy over intensity-modulated photon radiation therapy as highlighted in a wide real world data analysis. Radiother Oncol. 2024:110146.

85. Braunschweig R, Kildal D, Janka R. Artificial intelligence (AI) in diagnostic imaging. Rofo. 2024.

86. Qian ZY, Pan YQ, Li XX, Chen YX, Wu HX, Liu ZX, et al. Modulator of TMB-associated immune infiltration (MOTIF) predicts immunotherapy response and guides combination therapy. Sci Bull (Beijing). 2024.

87. Wu Y, Liu X, Huang Y, Zhou T, Zhang F. An open relaxation-diffusion MRI dataset in neurosurgical studies. Sci Data. 2024;11(1):177.

88. El Badisy I, Ben Brahim Z, Khalis M, Elansari S, ElHitmi Y, Abbass F, et al. Risk factors affecting patients survival with colorectal cancer in Morocco: survival analysis using an interpretable machine learning approach. Sci Rep. 2024;14(1):3556.

89. Monaco S, Bussola N, Buttò S, Sona D, Giobergia F, Jurman G, et al. AI models for automated segmentation of engineered polycystic kidney tubules. Sci Rep. 2024;14(1):2847.

90. Saidani O, Umer M, Alturki N, Alshardan A, Kiran M, Alsubai S, et al. White blood cells classification using multi-fold pre-processing and optimized CNN model. Sci Rep. 2024;14(1):3570.

91. Wang X, Sun H, Dong Y, Huang J, Bai L, Tang Z, et al. Development and validation of a cuproptosis-related prognostic model for acute myeloid leukemia patients using machine learning with stacking. Sci Rep. 2024;14(1):2802.

92. Li N, Fei P, Tous C, Rezaei Adariani M, Hautot ML, Ouedraogo I, et al. Human-scale navigation of magnetic microrobots in hepatic arteries. Sci Robot. 2024;9(87):eadh8702.

93. Choe YH, Lee S, Lim Y, Kim SH. Machine learning-derived model for predicting poor post-treatment quality of life in Korean cancer survivors. Support Care Cancer. 2024;32(3):143.

94. Lin WC, Chen WM, Shia BC, Wu SY. Prognostic factors for survival in unresectable stage III EGFR mutation-positive lung adenocarcinoma: impact of pre-CCRT PET-CT. Thorax. 2024.

95. Liao XY, Bao YG, Liu ZH, Yang L, Qiu S, Liu LR, et al. [Functional outcomes of robot-assisted radical prostatectomy with preservation of pelvic stabilized structure and early elevated retrograde liberation of neurovascular bundle]. Zhonghua Wai Ke Za Zhi. 2024;62(2):128-34.

96. Sarria GR, Kugel F, Roehner F, Layer J, Dejonckheere C, Scafa D, et al. Artificial Intelligence-Based Autosegmentation: Advantages in Delineation, Absorbed Dose-Distribution, and Logistics. Adv Radiat Oncol. 2024;9(3):101394.

97. Mohammadi G, Azizmohammad Looha M, Pourhoseingholi MA, Rezaei Tavirani M, Sohrabi S, Zareie Shab Khaneh A, et al. Classification and Diagnostic Prediction of Colorectal Cancer Mortality Based on Machine Learning Algorithms: A Multicenter National Study. Asian Pac J Cancer Prev. 2024;25(1):333-42.

98. Zhang J, Guo H, Wang L, Zheng M, Kong S, Wu H, et al. Cediranib enhances the transcription of MHC-I by upregulating IRF-1. Biochem Pharmacol. 2024;221:116036.

99. Ille AM, Markosian C, Burley SK, Mathews MB, Pasqualini R, Arap W. Generative artificial intelligence performs rudimentary structural biology modelling. bioRxiv. 2024.

100. Mukherjee S, Mukherjee A, Bytesnikova Z, Ashrafi AM, Richtera L, Adam V. 2D graphene-based advanced nanoarchitectonics for electrochemical biosensors: Applications in cancer biomarker detection. Biosens Bioelectron. 2024;250:116050.

101. Niu M, Wang C, Zhang Z, Zou Q. A computational model of circRNA-associated diseases based on a graph neural network: prediction and case studies for follow-up experimental validation. BMC Biol. 2024;22(1):24.

102. Li F, Wang B, Li H, Kong L, Zhu B. G6PD and machine learning algorithms as prognostic and diagnostic indicators of liver hepatocellular carcinoma. BMC Cancer. 2024;24(1):157.

103. Yu Y, Zu L, Jiang J, Wu Y, Wang Y, Xu M, Liu Q. Structure-aware deep model for MHC-II peptide binding affinity prediction. BMC Genomics. 2024;25(1):127.

104. Kumar S, Kumar H, Kumar G, Singh SP, Bijalwan A, Diwakar M. A methodical exploration of imaging modalities from dataset to detection through machine learning paradigms in prominent lung disease diagnosis: a review. BMC Med Imaging. 2024;24(1):30.

105. Lee SJ, Oh HJ, Son YD, Kim JH, Kwon IJ, Kim B, et al. Enhancing deep learning classification performance of tongue lesions in imbalanced data: mosaic-based soft labeling with curriculum learning. BMC Oral Health. 2024;24(1):161.

106. Sigg S, Lehner F, Keller EX, Saba K, Moch H, Sulser T, et al. Outcomes of robot-assisted laparoscopic extended pelvic lymph node dissection for prostate Cancer. BMC Urol. 2024;24(1):24.

107. Panagiotopoulou IG, Przedlacka A, Piozzi GN, Mills GA, Harper M, Khan JS. Robotic beyond total mesorectal excision (TME) for locally advanced or recurrent rectal cancer: a systematic review protocol. BMJ Open. 2024;14(1):e080043.

108. Schöler J, Alavanja M, de Lange T, Yamamoto S, Hedenström P, Varkey J. Impact of AI-aided colonoscopy in clinical practice: a prospective randomised controlled trial. BMJ Open Gastroenterol. 2024;11(1).

109. Ichikawa H, Yakushijin K, Kurata K, Tsuji T, Takemoto N, Joyce M, et al. Utility of the refined EBMT diagnostic and severity criteria 2023 for sinusoidal obstruction syndrome/veno-occlusive disease. Bone Marrow Transplant. 2024.

110. Dickhoff LRM, Scholman RJ, Barten DLJ, Kerkhof EM, Roorda JJ, Velema LA, et al. Keeping your best options open with AI-based treatment planning in prostate and cervix brachytherapy. Brachytherapy. 2024.

111. Han X, Guo Y, Ye H, Chen Z, Hu Q, Wei X, et al. Development of a machine learning-based radiomics signature for estimating breast cancer TME phenotypes and predicting anti-PD-1/PD-L1 immunotherapy response. Breast Cancer Res. 2024;26(1):18.

112. Sharma A, Weitz P, Wang Y, Liu B, Vallon-Christersson J, Hartman J, Rantalainen M. Development and prognostic validation of a three-level NHG-like deep learning-based model for histological grading of breast cancer. Breast Cancer Res. 2024;26(1):17.

113. Zhang HW, Huang DL, Wang YR, Zhong HS, Pang HW. CT radiomics based on different machine learning models for classifying gross tumor volume and normal liver tissue in hepatocellular carcinoma. Cancer Imaging. 2024;24(1):20.

114. Zhao Y, Dimou A, Fogarty ZC, Jiang J, Liu H, Wong WB, Wang C. Real-world Trends, Rural-urban Differences, and Socioeconomic Disparities in Utilization of Narrow versus Broad Next-generation Sequencing Panels. Cancer Res Commun. 2024;4(2):303-11.

115. Lee J, Cha S, Kim J, Kim JJ, Kim N, Jae Gal SG, et al. Ensemble Deep Learning Model to

Predict Lymphovascular Invasion in Gastric Cancer. Cancers (Basel). 2024;16(2).

116. Mitchell S, Nikolopoulos M, El-Zarka A, Al-Karawi D, Al-Zaidi S, Ghai A, et al. Artificial Intelligence in Ultrasound Diagnoses of Ovarian Cancer: A Systematic Review and Meta-Analysis. Cancers (Basel). 2024;16(2).

117. Christ SM, Pohl K, Willmann J, Heesen P, Heusel A, Ahmadsei M, et al. Patterns of metastatic spread and tumor burden in unselected cancer patients using PET imaging: Implications for the oligometastatic spectrum theory. Clin Transl Radiat Oncol. 2024;45:100724.

118. Wang X, Song Z, Zhu J, Li Z. Correlation Attention Registration Based on Deep Learning from Histopathology to MRI of Prostate. Crit Rev Biomed Eng. 2024;52(2):39-50.

119. Van Dieren L, Amar JZ, Geurs N, Quisenaerts T, Gillet C, Delforge B, et al. Unveiling the power of convolutional neural networks in melanoma diagnosis. Eur J Dermatol. 2023;33(5):495-505.

120. Ross AE, Zhang J, Huang HC, Yamashita R, Keim-Malpass J, Simko JP, et al. External Validation of a Digital Pathology-based Multimodal Artificial Intelligence Architecture in the NRG/RTOG 9902 Phase 3 Trial. Eur Urol Oncol. 2024.

121. Liu Y, Feng Y, Qian L, Wang Z, Hu X. Deep learning diagnostic performance and visual insights in differentiating benign and malignant thyroid nodules on ultrasound images. Exp Biol Med (Maywood). 2023;248(24):2538-46.

122. Fang Y, Chen X, Cao C. Cancer immunotherapy efficacy and machine learning. Expert Rev Anticancer Ther. 2024;24(1-2):21-8.

123. Son S, Joo B, Park M, Suh SH, Oh HS, Kim JW, et al. Development of RLK-Unet: a clinically favorable deep learning algorithm for brain metastasis detection and treatment response assessment. Front Oncol. 2023;13:1273013.

124. Vaish R, Mahajan A, Ghosh Laskar S, Prabhash K, Noronha V, D'Cruz AK. Editorial: Site specific imaging guidelines in head & neck, and skull base cancers. Front Oncol. 2024;14:1357215.

125. Masuzawa T, Sugimura K, Katsuyama S, Yanagisawa K, Shinke G, Kinoshita M, et al. [Robot Assisted Para-Aortic Lymphadenectomy in Gastric Cancer Surgery]. Gan To Kagaku Ryoho. 2023;50(13):1709-11.