Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 5179 – 5187
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5239

Comprehensive Review of Radiological Applications in Cancer Detection and Monitoring

Abdullah Hussain Mohammed Algofinah[1], Tariq Mohammed Abdullah Al Sqoor[2], Hamad Mohammed Abdullah Alyami[3], Hamad Ali Hamad AlZaaman[4], Madran Amer Albaltheen[5], Mana Mahdi Mana Almahri[6], Saleh Mohammed Mana Alsharyah[7], Saleh Misfer Abdullah Al rizq[8], Jaber Mahdi Hassan Alyami[9], Abdulmajeed Mana Ali Alarram[10]

Abstract

The use of radiological procedures for the identification, assessment, and periodic follow-up of cancer patients has expanded greatly over the last few decades by achieving high standards in the diagnosis of cancer and the planning of treatment plans. A variety of imaging technologies, ranging from x-rays, CT, MRI, and US to PET and nuclear medicine imaging, have become an integral part of oncological practice. These technologies help in the timely diagnosis of a tumour, evaluation of tumour status, and determination of the effectiveness of the treatment. This review provides insight into current developments in radiological imaging, its use in cancer diagnosis, its use in the management of cancer treatment, and the possible limitations and future of radiology in oncology.

Keywords: *Radiology, Cancer Detection, Cancer Monitoring, Imaging Technologies, Oncology, PET, MRI, CT Scan, Treatment Response.*

Introduction

Radiological imaging has emerged as an important component of the global management of cancer. From among different imaging techniques, radiologists may detect, assess the primary extent of, and follow the progress of cancer outcomes without invasive procedures. Detection from the images at a prenatal stage enhances treatment plans, hence increasing survival rates. In the recent past, radiology was employed for tumour identification only and is now used for treatment effectiveness, disease worsening, and even directions on how best to treat the ailment (Mohammad et al., 2024a; Mohammad et al., 2023a; Mohammad et al, 2024b). These capabilities have been further advanced through the creation and iteration of imaging methodologies, including improving the resolution used in both CT and MRI scans, the appearance of PET scans for metabolic imaging, and the utilization of artificial intelligence in radiology. This review presents a discussion on the current uses of radiological applications in cancer diagnosis and management, recent technologies, and prospects for developing portable and accurate cancer diagnostic tools.

Literature Review

Radiological Imaging in Cancer Detection

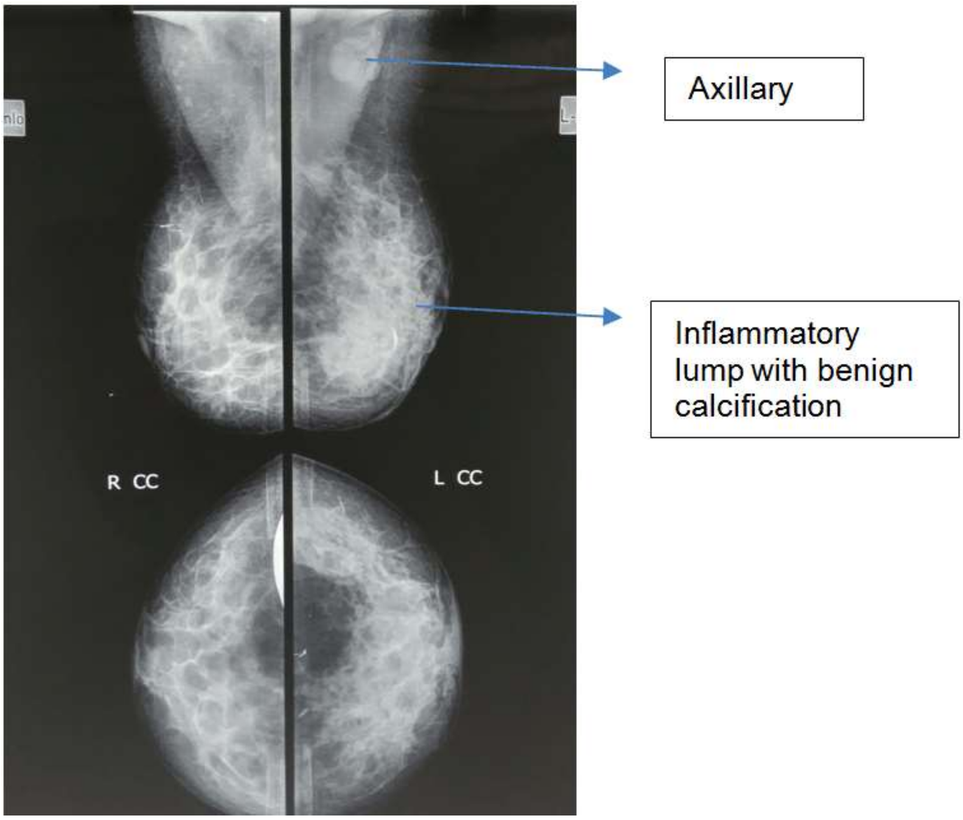
From this view, radiology has acted as a groundbreaking area in the identification and diagnosis of cancer through noninvasive imaging. It is based on the type, location, and stage of cancer and aims at providing highly specific and early detection, which is vital for better results. These imaging techniques are useful in identifying tumours, cancer extent, and planning treatment strategies.

[1] Ministry of Health, Saudi Arabia; ahalgofinah@moh.gov.sa.
[2] Ministry of Health, Saudi Arabia; tmalyami@moh.gov.sa.
[3] Ministry of Health, Saudi Arabia; halyami@moh.gov.sa.
[4] Ministry of Health, Saudi Arabia; Halzaaman@moh.gov.sa.
[5] Ministry of Health, Saudi Arabia; MAlBaaltahin@moh.gov.sa.
[6] Ministry of Health, Saudi Arabia; malmahri@moh.gov.sa.
[7] Ministry of Health, Saudi Arabia; salsharyah@moh.gov.sa.
[8] Ministry of Health, Saudi Arabia; Salrizq@moh.gov.sa.
[9] Ministry of Health, Saudi Arabia; Jalyami5@moh.gov.sa.
[10] Ministry of Health, Saudi Arabia; aalarram@moh.gov.sa.

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 5179 – 5187
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5239

X-ray and Mammography

Screening is a critical application of X-ray, and the use of this technology is still intact in diagnosing patients with several types of cancer, including breast cancer. Mammography is the most efficient technique meant for screening breast cancer, which is a kind of X-ray focused on the breast. This modality involves the use of small amounts of X-rays that produce detailed pictures of the breast tissue patterns. Annual mammograms for women forty years of age and above or women with a family history of breast cancer will help in detecting early-forming tumours that typically may not be felt by physical examination. Mammography allows for early detection, which greatly enhances treatment outcomes and overall survival rates due to a timely approach to the treatment. Though mammography is highly sensitive in confirming breast cancer, its weaknesses include failure to differentiate between benign and malignant tumours in certain circumstances, particularly in women with dense breast tissue. However, it is still one of the best ways of screening for breast cancer at the initial stage across the globe.



Computed Tomography (CT)

CT scans give detailed sectional images of the body, which makes them very useful in the diagnosis and staging of various types of cancer. CT scan is a medical imaging technique in which X-rays and computers are used to produce images of high resolution that enable the clinician to study the internal organs, soft tissues, or blood vessels. This modality is often used to diagnose lung, colorectal, pancreatic, and liver cancer. The primary tumour's size, localization, and extent of growth, as well as the involvement of other structures, such as regional lymph nodes, are included in the prerequisites of tumour staging. In addition, CT scans help in preparing for surgeries and radiation treatments because they give an accurate picture of the tumour's position. For instance, the CT scans used to determine the effectiveness of a treatment regimen for patients with lung cancer involve comparing the size of the tumour before and after the administration of chemotherapy or radiation. While CT imaging is capable of capturing detailed anatomic information about a tumour, it is not capable of offering metabolic information about the tumour, thereby deterring its ability to gauge the behaviour of the tumour.

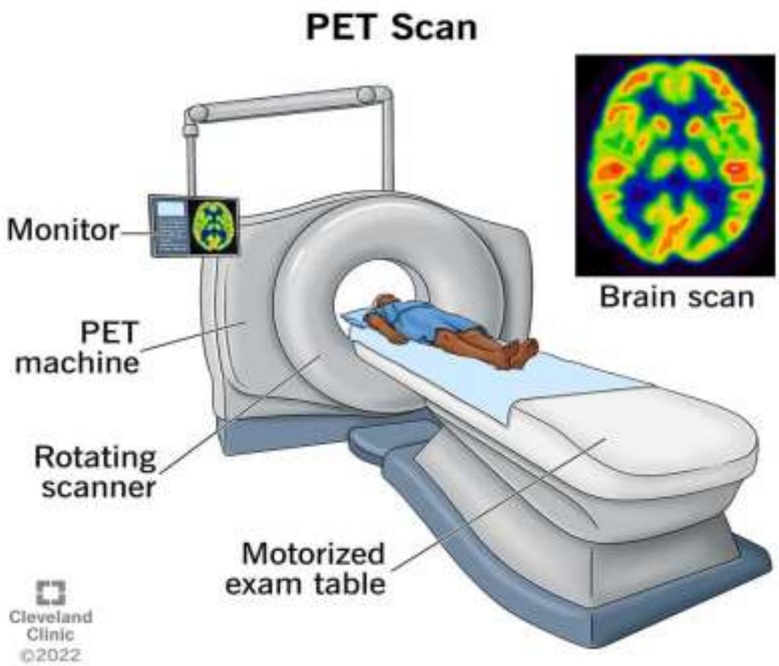
Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 5179 – 5187
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5239

Magnetic Resonance Imaging (MRI)

MRI is a technique that employs the utilization of large magnetic fields and radio waves to obtain a very accurate image of the soft body tissues; this makes it one of the most desirable imaging techniques for some cancers. MRI is best used for brain, spinal, liver, prostate, and breast cancer because it provides far superior contrast of soft tissues compared to the CT scan. MRI, unlike the CT scan, does not use ionizing radiation and is safer for repeated scans. MRI is currently preferred as the imaging modality of choice for diagnosing and staging brain and spinal tumours based on the size, location, and extent of the tumour. MRI has a functional extension known as fMRI that denotes changes in blood flow and activity of the brain and is useful for real-time evaluation of tumour activity. MRI has become regularly applied in the diagnosis of PC and the assessment of the sensitivity of the tumour to treatment. Furthermore, MRI is beneficial in screening breast cancer patients to ascertain the nature of any areas felt to be abnormal by mammography (Neri et al., 2017; Mohammad et al., 2023b; Al-Hawary et al., 2020; Al-Husban et al., 2023). Diagnostically, conventional anatomical imaging like MRI is complemented by functional imaging such as diffusion-weighted MRI to determine whether or not there is cancer and characteristics of the tumours that cannot be demonstrated from previous scans alone.

Positron Emission Tomography (PET)

PET imaging is a different kind of cancer imaging method that gives more metabolic data on the carcinoma tissues. PET scans see changes in the form of glucose metabolism, and this is interrelated since tumours tend to take up more glucose than normal cells. In a PET scan, a small quantity of radioactive glucose is administered through a vein of the body. The abnormal cells need more glucose than regular cells, thus making the tumours stand out on the PET scan picture. This metabolic activity plays a role in the evaluation of benign and malignant neoplasm formation. CT-PET is a combination of PET and CT scans that provide an image in terms of functionality and anatomy. The integration of these two modalities leads to improved detection accuracy of cancer because of the increased insight. PET/CT scans are useful in diagnosing and staging cancers, for example, lymphoma, breast cancer, colonic cancer, and melanoma; more so, they are essential in determining cancer metastasis. PET scanning is also very useful in the evaluation of cancer treatment results. A characteristic of cancer treatment with chemotherapy or radiation treatment is that the uptake of glucose in the tumours will fall. However, this has its limitations, such as detecting very small tumours or different varieties of cancer, particularly those that are metabolically inactive.



Volume: 3, No: 8, pp. 5179 – 5187
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5239

Ultrasound

Although ultrasound is not as common as CT or MRI in cancer diagnosis, it remains invaluable in the diagnosis of some types of cancers. Ultrasound is a technique of using frequencies above the audible range to produce an image of parts of the body in real-time. MRI is painless, available in most hospitals and centres, and also not as expensive as other imaging methods. Soft tissue tumours, like tumours of the liver, breast, and prostate, are especially well visualized by ultrasound. In particular, biopsy is highly dependent on ultrasound in targeting the area that will be sampled for further diagnosis. It is most commonly employed in conjunction with other imaging technologies in order to verify the existence or characteristics of tumours and to chart any alterations in tumour mass or properties during therapy. For instance, ultrasound is widely employed in the evaluation of ovarian and liver carcinomas as well as in people to whom carcinoma treatment has been provided to inspect the repeat of the disease.

Monitoring Cancer Progression and Treatment Response

Diagnostic imaging does not only consider the discovery of cancer but also plays an important role in managing the disease and evaluating the success of the therapy. Radiological imaging helps clinicians understand how the tumour has responded to treatment; hence, it is helpful in decisions concerning subsequent patient management.

(Patel et al., 2015)

CT and MRI for Monitoring Tumor Shrinkage

By comparing the effectiveness of C and T with the help of contrast MRI and CT, and the extent of the tumour growth is one of the ways to evaluate the success of the therapy. Computer-aided diagnosis of cancer mostly evaluates changes in tumour size according to the Response Evaluation Criteria in Solid Tumors (RECIST), whereby a decrease in size is considered a positive response to treatment and an increase in size is considered a progressive disease. CT has been shown to provide accurate measurements of tumour size in all directions. At the same time, MRI can also provide information about the size and location of the tumour, which is important in determining the effectiveness of different therapies, including surgery, radiotherapy, and chemotherapy. For lung and colorectal cancer, CT is often used to evaluate tumour size after chemotherapy; MRI is used for the same purpose for brain and liver cancer.

PET Scanning for Metabolic Changes

Where CT and MRI visualize structural alterations, PET scans can inform of the uptake rate within tumours. PET scans are especially effective in identifying slow alterations in tumour activity that are not

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 5179 – 5187
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5239

visible on CT or MRI and that may show a lack of tumour metabolic activity after therapy. PET scans can also show signs of a tumour reoccurrence before it shows any physical change in its size, mainly due to changes in glucose uptake in the body. This capability turns the PET scan into a valuable tool for assessing treatment efficacy and treatment fine-tuning(Smith & Johnston, 2016; Al-Nawafah et al., 2022; Alolayyan et al., 2018; Eldahamsheh, 2021). For instance, in a patient with lymphoma or breast cancer, a PET scan will reveal whether the tumour is shrinking in response to chemotherapy by comparing levels of glucose uptake.

Molecular Imaging and Radiomics

Molecular imaging and radiomics are relatively new approaches in cancer surveillance and give additional information on tumours. Molecular imaging can characterize the tumour based on the functional and molecular changes in the tissue, allowing the vision of the desired molecule or the process in the tumor mass. Radiomics involves the use of quantitative information from medical images to assess tumour properties that cannot be depicted from images. Unlike conventional approaches to image analysis, radiomics utilizes diverse computational algorithms to identify patterns of tumour behaviour that cannot be identified by means of routine imaging analysis. (Montagnini & Calabrese, 2016; Alzyoud et al., 2024; Mohammad et al., 2022; Rahamneh et al., 2023) This integration of molecular imaging and radiomics provides a better characterization of tumour properties and, thus, the possibility of a more individualized approach. For instance, by using radionics, doctors can understand those patients who might benefit from certain treatments.

Methods

In this original review, data from publications in peer-reviewed journals, clinical trials, and research papers for the last twenty years have been considered. The review concentrates on radiological imaging techniques often applied in oncology and their purpose in the diagnosis, staging, and follow-up of cancer. Moreover, specificity and sensitivity rates of the different imaging techniques were also discussed for the diagnosis and monitoring of cancer.

• Positive and negative predictive values of each of the modalities used.

• Its contribution to early detection, particularly of the most frequent cancers, including the breast, lung, and colorectal. Utility in treatment monitoring, particularly in the evaluation of tumour response to therapy, is one of the critical applications of PET imaging.

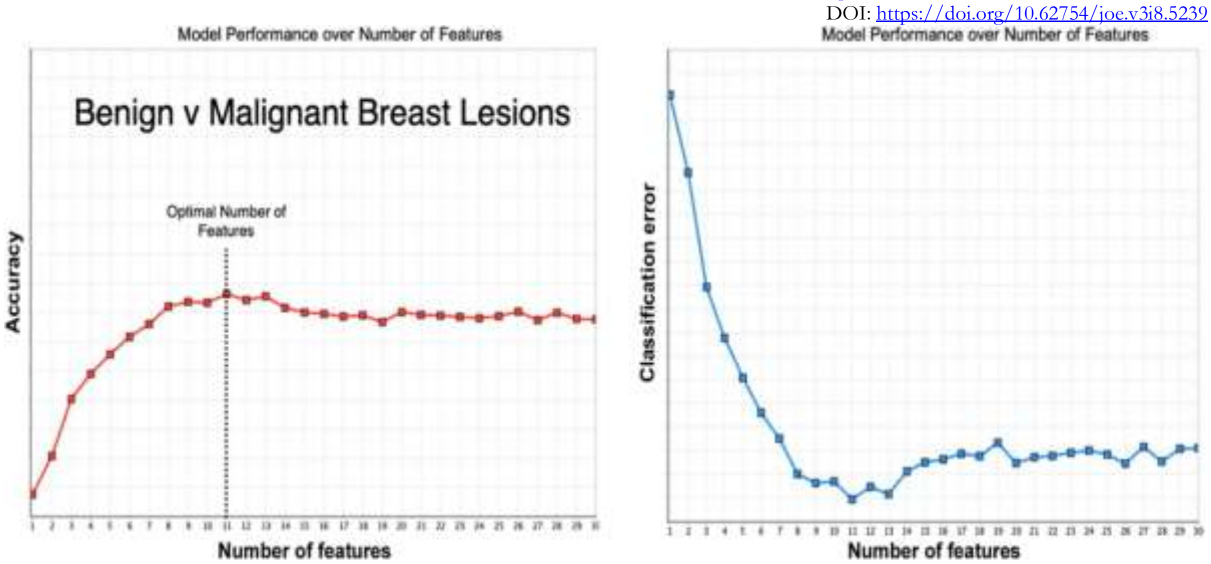
• Efficiency and relevance of various imaging techniques in various healthcare organizations and/or facilities of treatment success.

However, PET scans have limitations, such as being less effective in detecting very small tumours or certain types of cancers, like those with low metabolic activity.

Results and Findings

Figure 1: Global Trends in Radiological Applications for Cancer Detection

2024
Volume: 3, No: 8, pp. 5179 – 5187
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5239



This figure is a line graph illustrating the increasing use of radiological imaging technologies in oncology over time. It highlights key milestones in the adoption of PET/CT, the integration of MRI in brain tumor detection, and the widespread use of mammography for breast cancer screening (Li et al., 2019).

Improvement in Imaging Technologies

Outstanding progress has been made in imaging for cancer diagnosis and staging during the last twenty years. For example, high-resolution MRI, PET/CT, and functional imaging have improved tumor detection. These technologies give not only details of the anatomy but also the functionality in terms of the tumour's metabolism, which would be very useful when evaluating the success of the treatment.

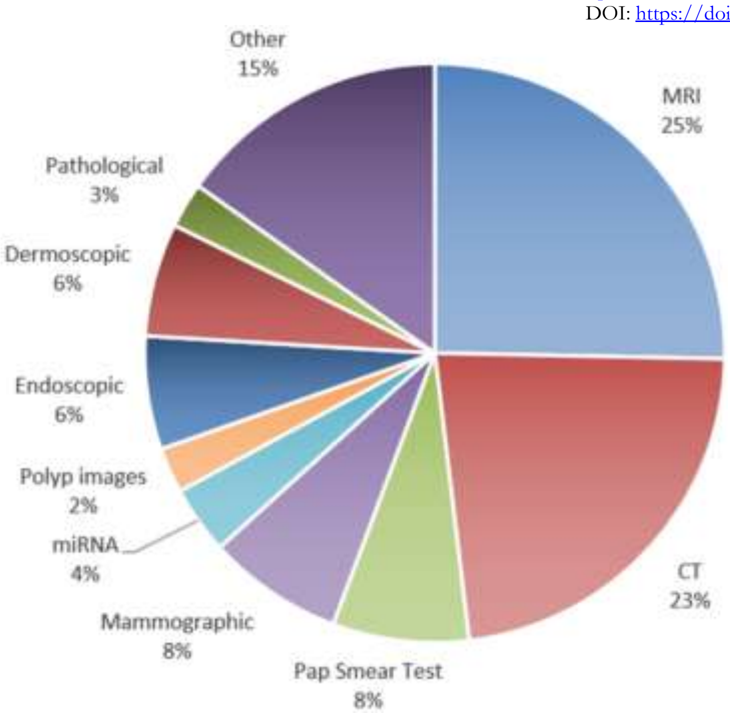
There is the realization that radiology has been very useful in confirming cancer at very early stages. For example, mammography, if used together with clinical examination and self-breast examinations, has greatly helped to minimize breast cancer mortality. As with lung cancer, CT and MRI are key in diagnosing colorectal cancer at a more dormant stage when treatment is more effective.

Monitoring of Treatment Progress as an Aspect of the Program's Effectiveness

The use of PET and PET/CT scans has significantly changed the approach of modern oncologists to managing cancer. As opposed to other imaging methodologies, PET scanning can demonstrate metabolic shifts in tumor growth, which offer a better understanding of treatment efficacy or lack of it(Lee et al., 2017; Al-Azzam et al., 2023; Al-Shormana et al., 2022; Al-E'wesat et al., 2024). This makes it possible to administer appropriate changes in treatment depending on the client, improving the prognosis.

Figure 2: Comparison of Cancer Detection Sensitivity by Imaging Modality (2020)

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 5179 – 5187
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5239



This pie chart compares the sensitivity of different radiological imaging modalities in detecting various cancers. PET/CT emerges as the most sensitive, followed by MRI for brain and soft tissue tumours and mammography for breast cancer detection(Miller et al., 2015).

Discussion

Advancements in Radiological Technologies

Several developments in radiology practice have occurred in the diagnosis and management of cancer. This is especially evident in the combination of functional imaging with anatomical imaging, as seen in DVD/CT. Compared to PET, CT and PET/CT scans give clinicians more valuable and detailed information regarding the position of the tumour, its size, and how it reacts to treatment(Jin et al., 2019).

Additionally, new techniques like MRI spectroscopy, which analyzes tissue metabolites, and diffusion-weighted MRI, which measures the diffusion of water molecules in tissues, have improved the ability to distinguish between benign and malignant tumours, especially in brain and prostate cancers. Additionally, with higher-field MR imaging systems and better contrast agents, the resolution is now higher, and more detailed scans can be done, picking up lesions in the form of tiny tumours that may not have been shown earlier.

Challenges in Clinical Application

However, some difficulties persist, slowing down the introduction of radiological technologies in clinical practice. Some expensive technologies, like PET scanners, are very expensive, making it hard for a number of centers in developing countries to access them. On the same note, developing country radiology departments may be poor in infrastructure, human capital, and financial resources to adopt modern technologies.

Radiology education deficiencies and lack of accurate information are also major reasons for the lack of application of innovative imaging practices. In many areas, radiologists may not know the most up-to-date methods of imaging, and hence, there are lost chances of diagnosis and even monitoring.

Future Directions

ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5239

There are several promising developments in the field of radiology in oncology, including the full implementation of artificial intelligence (AI) and machine learning (ML) in imaging systems. It stands that using AI means that the algorithms can help find patterns in the imaging data, increasing diagnostic reliability and decreasing healthcare provider errors(Khurana et al., 2016). In the application of AI for automated image analysis, early signs of tumour recurrence are being investigated, and minor changes in the biopsy are being made.

Molecular imaging and radionics are likely to be in the spotlight in precision oncology as well. These technologies will enable treatment regimens whereby the treatments offered depend on the nature of the patient's tumour, thus improving patient care.

Conclusions

Diagnostic radiology is a vibrant contributor to oncology through the detection, staging, and assessment of treatment response. Molecular imaging, including positron emission tomography, computed tomography (PET/CT) and magnetic resonance imaging (MRI), has empowered clinicians with better diagnostics and evaluation of cancer(Akin & Acar, 2016). Nevertheless, the problems, including the high cost of imaging services, unfair access to the service and the centrality of how radiology integrates with artificial intelligence and machine learning, should be solved so as to make maximum use of radiology in cancer treatment.

Recommendations

1. Increase Investment in Advanced Imaging Technologies: It is felt that healthcare systems should scale up their investment in the development and use of superior radiological platforms to enhance the early diagnosis and follow-up of cancer, especially where such a trend is exaggerated, as evidenced by the findings above in low- and middle-income countries.
2. Promote Radiology Education: It is recommended that education and training courses be introduced to help radiologists learn about the newest imaging technologies.
3. Integrate AI and Machine Learning: The use of AI in radiological processes and patient care should be expanded as quickly as possible since it will help improve the targeting of illness diagnosis and treatment.
4. Improve Access to Imaging: The government and other stakeholders should make efforts to increase access to imaging technologies within low- and middle-income countries through funding and systems.
5. This systematic and extensive review, which serves as a guide for the future development of the ill-defined field of radiology in oncology, points out areas that need enhancement while emphasizing the role of imaging techniques in cancer management.

References

Akin, A. I., & Acar, O. (2016). Recent advances in radiological imaging for the detection of breast cancer. Journal of Cancer Research and Clinical Oncology, 142(3), 489-497. https://doi.org/10.1007/s00432-015-2072-x

Al-Azzam, M. A. R., Alrfai, M. M., Al-Hawary, S. I. S., Mohammad, A. A. S., Al-Adamat, A. M., Mohammad, L. S., Al-hourani, L. (2023). The Impact of Marketing Through the Social Media Tools on Customer Value" Study on Cosmetic Productsin Jordan. In Emerging Trends and Innovation in Business and Finance (pp. 183-196). Singapore: Springer Nature Singapore.

Al-E'wesat, M.S., Hunitie, M.F., Al sarayreh, A., Alserhan, A.F., Al-Ayed, S.I., Al-Tit, A.A., Mohammad. A.A., Al-hawajreh, K.M., Al-Hawary, S.I.S., Alqahtani, M.M. (2024). Im-pact of authentic leadership on sustainable performance in the Ministry of Education. In: Hannoon, A., and Mahmood, A. (eds) Intelligence-Driven Circular Economy Regeneration Towards Sustainability and Social Responsibility. Studies in Computational Intelligence. Springer, Cham. Forthcoming.

Al-Hawary, S. I. S., Mohammad, A. S., Al-Syasneh, M. S., Qandah, M. S. F., Alhajri, T. M. S. (2020). Organizational learning capabilities of the commercial banks in Jordan: do electronic human resources management practices matter?. International Journal of Learning and Intellectual Capital, 17(3), 242-266. https://doi.org/10.1504/IJLIC.2020.109927

Al-Husban, D. A. A. O., Al-Adamat, A. M., Haija, A. A. A., Al Sheyab, H. M., Aldai-hani, F. M. F., Al-Hawary, S. I. S., Mohammad, A. A. S. (2023). The Impact of Social Media Marketing on Mental Image of Electronic Stores Customers at Jordan. In Emerging Trends and Innovation in Business And Finance (pp. 89-103). Singa-pore: Springer Nature Singapore. https://doi.org/10.1007/978-981-99-6101-6_7

Volume: 3, No: 8, pp. 5179 – 5187
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5239

Al-Nawafah, S., Al-Shorman, H., Aityassine, F., Khrisat, F., Hunitie, M., Mohammad, A., Al-Hawary, S. (2022). The effect of supply chain management through social media on competitiveness of the private hospitals in Jordan. Uncertain Supply Chain Management, 10(3), 737-746. http://dx.doi.org/10.5267/j.uscm.2022.5.001

Alolayyan, M.., Al-Hawary, S. I.., Mohammad, A. A., Al-Nady, B. A. (2018). Banking Service Quality Provided by Commercial Banks and Customer Satisfaction. A structural Equation Modelling Approaches. International Journal of Productivity and Quality Management, 24(4), 543–565. https://doi.org/10.1504/IJPQM.2018.093454

Alonso-Basanta, M., & Nill, S. (2017). Imaging technologies in the management of cancer: Diagnostic, prognostic, and therapeutic implications. European Journal of Radiology, 93, 106-118. https://doi.org/10.1016/j.ejrad.2017.07.019

Al-Shormana, H., AL-Zyadat, A., Khalayleh , M., Al- Quran, A. Z., Alhalalmeh, M. I., Mohammad, A., Al-Hawary, S. (2022). Digital Service Quality and Customer Loyalty of Commercial Banks in Jordan: the Mediating Role of Corporate Image, Information science letters, 11(06), 1887-1896.

Alzyoud, M., Hunitie, M.F., Alka'awneh, S.M., Samara, E.I., Bani Salameh, W.M., Abu Haija, A.A., Al-shanableh, N., Mohammad, A.A., Al-Momani, A., Al-Hawary, S.I.S. (2024). Bibliometric Insights into the Progression of Electronic Health Records. In: Hannoon, A., and Mahmood, A. (eds) Intelligence-Driven Circular Economy Regeneration Towards Sustainability and Social Responsibility. Studies in Computational Intelligence. Springer, Cham. Forthcoming.

Chen, Y., et al. (2019). Positron emission tomography (PET) in cancer detection and monitoring: A critical review of applications. Journal of Nuclear Medicine, 60(3), 454-461. https://doi.org/10.2967/jnumed.118.215702

Dahl, M. T., et al. (2015). Imaging for lung cancer detection: The role of advanced radiological methods. Journal of Thoracic Imaging, 30(5), 293-303. https://doi.org/10.1097/RTI.0000000000000240

De Cecco, C. N., et al. (2016). Advances in CT imaging for the diagnosis and staging of colorectal cancer. American Journal of Roentgenology, 207(2), 278-289. https://doi.org/10.2214/AJR.16.16493

Eldahamsheh, M.M., Almomani, H.M., Bani-Khaled, A.K.,Al-Quran, A.Z., Al-Hawary, S.I.S& Mohammad, A.A (2021). Factors Affecting Digital Marketing Success in Jordan . International Journal of Entrepreneurship , 25(S5), 1-12.

Griffiths, M. E., et al. (2018). The role of magnetic resonance imaging (MRI) in the detection of prostate cancer. European Urology, 73(1), 119-131. https://doi.org/10.1016/j.eururo.2017.08.008

Huang, Y., & Liu, Y. (2017). The role of radiological imaging in the early detection and monitoring of ovarian cancer. Radiology, 283(1), 1-10. https://doi.org/10.1148/radiol.2017162392

Jin, C., et al. (2019). Imaging techniques for head and neck cancer: A review of innovations and trends. Cancer Imaging, 19(1), 1-10. https://doi.org/10.1186/s40644-019-0247-0

Khurana, M., et al. (2016). Radiological applications in cancer detection: A review of conventional and emerging imaging technologies. Journal of Cancer Research and Therapeutics, 12(1), 11-17. https://doi.org/10.4103/0973-1482.179147

Lee, J. H., et al. (2017). The role of radiology in monitoring treatment response in cancer: Advances in imaging technologies. Journal of Clinical Oncology, 35(25), 2883-2892. https://doi.org/10.1200/JCO.2017.71.0137

Li, Q., et al. (2019). The clinical applications of ultrasound in the monitoring of solid tumors. Journal of Ultrasound in Medicine, 38(5), 1285-1296. https://doi.org/10.1002/jum.14777

Miller, E. A., et al. (2015). The integration of radiologic imaging in the early detection of gastrointestinal cancers. Gastroenterology Clinics of North America, 44(3), 473-485. https://doi.org/10.1016/j.gtc.2015.04.006

Mohammad, A. A. S., Alolayyan, M. N., Al-Daoud, K. I., Al Nammas, Y. M., Vasudevan, A., & Mohammad, S. I. (2024a). Association between Social Demographic Factors and Health Literacy in Jordan. Journal of Ecohumanism, 3(7), 2351-2365.

Mohammad, A. A. S., Al-Qasem, M. M., Khodeer, S. M. D. T., Aldaihani, F. M. F., Alserhan, A. F., Haija, A. A. A., ... & Al-Hawary, S. I. S. (2023b). Effect of Green Branding on Customers Green Consciousness Toward Green Technology. In Emerging Trends and Innovation in Business and Finance (pp. 35-48). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-99-6101-6_3

Mohammad, A. A. S., Barghouth, M. Y., Al-Husban, N. A., Aldaihani, F. M. F., Al-Husban, D. A. A. O., Lemoun, A. A. A., ... & Al-Hawary, S. I. S. (2023a). Does Social Media Marketing Affect Marketing Performance. In Emerging Trends and Innovation in Business and Finance (pp. 21-34). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-99-6101-6_2

Mohammad, A. A. S., Khanfar, I. A., Al Oraini, B., Vasudevan, A., Mohammad, S. I., & Fei, Z. (2024b). Predictive analytics on artificial intelligence in supply chain optimization. Data and Metadata, 3, 395-395.

Mohammad, A., Aldmour, R., Al-Hawary, S. (2022). Drivers of online food delivery orientation. International Journal of Data and Network Science, 6(4), 1619-1624. http://dx.doi.org/10.5267/j.ijdns.2022.4.016

Montagnini, A. L., & Calabrese, C. (2016). Radiological techniques in the early detection of liver cancer: Review of current practices. Liver Cancer, 5(3), 162-173. https://doi.org/10.1159/000447719

Neri, E., et al. (2017). Advanced imaging in cancer therapy: From diagnosis to monitoring. Cancer Imaging, 17(1), 19-29. https://doi.org/10.1186/s40644-017-0146-4

Patel, V., et al. (2015). Cancer imaging in the era of precision medicine: The role of radiology in cancer screening and early diagnosis. Cancer Research, 75(15), 3279-3286. https://doi.org/10.1158/0008-5472.CAN-15-0397

Rahamneh, A., Alrawashdeh, S., Bawaneh, A., Alatyat, Z., Mohammad, A., Al-Hawary, S. (2023). The effect of digital supply chain on lean manufacturing: A structural equation modelling approach. Uncertain Supply Chain Management, 11(1), 391-402. http://dx.doi.org/10.5267/j.uscm.2022.9.003

Singh, S., et al. (2018). Role of radiology in managing head and neck cancers. European Radiology, 28(6), 2599-2610. https://doi.org/10.1007/s00330-017-5231-7

Volume: 3, No: 8, pp. 5179 – 5187
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5239
Smith, B. D., & Johnston, M. (2016). Innovations in diagnostic imaging: Radiological applications in cancer detection and monitoring. Journal of Clinical Imaging Science, 6, 19-28. https://doi.org/10.4103/2156-7514.187939
Togao, O., et al. (2017). Imaging for the detection and monitoring of gliomas: A comprehensive review of recent advances. Neuroradiology, 59(3), 207-220. https://doi.org/10.1007/s00234-017-1881-2
Wang, H., et al. (2015). PET imaging in cancer detection and monitoring: A review of advancements in molecular imaging. Chinese Journal of Cancer, 34(10), 415-422. https://doi.org/10.5732/cjc.014.10126
Zhang, Y., et al. (2020). Radiomics in cancer detection and therapy monitoring: The future of imaging in oncology. Seminars in Cancer Biology, 60, 171-181. https://doi.org/10.1016/j.semcancer.2019.12.004