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The Artificial Intelligence Era: The Role of Radiologic Technologists and Radiation Therapists

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Abstract
The most talked-about topic in medical imaging research today, both for diagnostic and therapeutic purposes, is unquestionably artificial intelligence (AI). AI has been used by researchers to quantitatively evaluate radiographic features and automatically identify intricate patterns in imaging data. AI has been applied to many image modalities utilized at various phases of treatment in radiation oncology. For example, tumor delineation and treatment evaluation. AI is the crucial component that increases the processing capacity of large volumes of medical images, hence revealing illness features that are invisible to the human eye. The main objective of this paper is to evaluate the application and usage of AI in medical imaging and Radiology and also to assess the role of Radiologist in the same.

Keywords: Radiology, AI, OEM, Radiologist, Technicians.

Introduction
It is evident from earlier estimates that between 2018 and 2022, over half of world health care officials anticipated the use of AI to increase in illness monitoring and diagnosis. Certain imaging applications already make use of AI-enabled equipment. About 10% of the entire AI business is made up of medical imaging, which is expected to double in size by 2026. The market for medical imaging AI is anticipated to grow to about $264 billion by 2028. Its ability to capture, evaluate, plan, and store images puts medical imaging and radiation therapy in a position to benefit from AI skills. These days, photos are based on data (digitally), which makes it simpler to find and create data sets because the data is already there. **Tanguay et al (2023); Hardy et al (2020)**
Medical imaging transformation in cardiac care that involves:
➢ [Processing – extracting image parameters automatically"
➢ [Assessment – fully quantitative diagnostic scores and risk stratification"
➢ [Scaling up – adding real-time machine learning metrics that incorporate large databases of clinical and imaging variables that are beyond human cognitive ability"
➢ [Customization – personalized risk assessments and management plans for patients"
Equipment or software with AI capabilities is used in a number of medical imaging and radiation therapy applications. Others are being worked on and will probably be incorporated into the professions soon. **Rezazade et al (2021)**
Some Examples:
A. Computer-aided diagnosis (CADx) and detection (CADe). The progress of AI techniques in medical imaging and how AI concentrates on particular tasks are demonstrated by CAD, which is one of the first clinical applications of AI processes in radiology. Generally, systems are designed to identify disease indicators in a particular body part, such breast cancer on mammograms. Interpreting radiologists are typically alerted to suspicious or abnormal areas by CADe systems. **van et al (2022)** In order to quantify the severity, stage, or efficacy of treatment (regression or progression), CADx systems assist in evaluating a mass or area. Classifying benign and malignant brain tumors has advanced significantly. When the

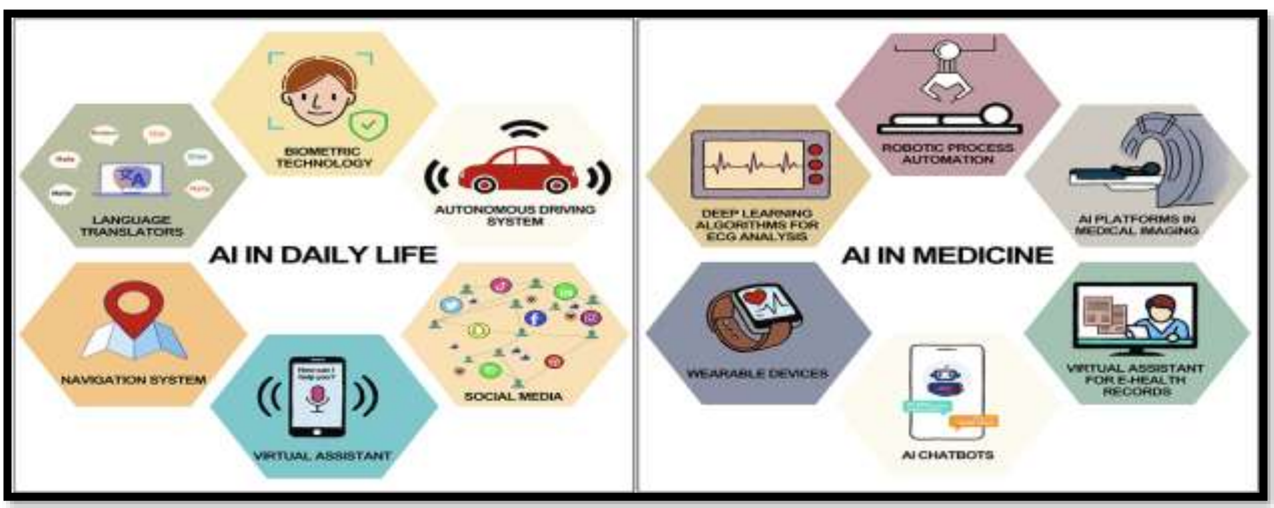
program that CAD is built on starts to learn on its own, much like humans do, it turns into true AI. **Stogiannos et al (2021)**

B. Prescreening for emergencies. Training programs to quickly test for and identify collapsed lung using information from radiology and pathology images is part of using AI to prescreen patients for pneumothorax. Despite not being important, up to 62% of requests for portable chest radiographs are labeled as such. GE's Critical Care Suite, which employs AI to scan chest radiographs, identify pneumothorax, and forward the image straight to a radiologist, was authorized by the U.S. Food and Drug Administration (FDA) in October 2019. This procedure can cut down on the amount of time needed for diagnosis and the number of possibly negative photos that need to be marked as urgent. **Odle et al (2020)**

C. Positioning itself automatically. Some positioning-related jobs have been automated by AI technology, saving time on tedious, manual labor. For a CT scan, automated placement detects, for instance, a patient's head rather than the technologist placing the patient's anatomy in crosshairs. This automation can help optimize dosage and save time when situating patients. Depending on the particular technique, the CT table can automatically move to place the patient's body. When imaging juvenile patients or in unexpected or traumatizing settings, radiologic technologists must confirm and modify the auto position as necessary. **Malamateniou et al (2021)**

D. MR image slicing that is automatic. By selecting slices automatically, the MR technologist can eliminate the needless manual processes that they usually take. After detecting anatomical structures, AI-based technology programs slice sites and angles. Imaging of difficult anatomy, such the optic nerve, can be made easier by the accuracy of automated placement. Tens of thousands of MR pictures are needed to create the database for a neural network. Automatic identification of anatomical features. **Ryan et al (2021)**

Time-consuming procedures like combining electronic medical records and scheduling patients or recalls automatically are already possible, as is data mining of pertinent information like radiation dose. Even though 123 vendors took part in an AI Showcase at the 2019 RSNA convention, less than one in four AI algorithms were FDA 510(k) certified. Additional uses of AI for medical imaging include the detection of breast cancer in breast MR imaging, the interpretation of chest radiographs, the identification of brain tumors, the detection of prostate cancer, and the description of liver lesions on ultrasound. The principles of facial recognition are being used to find cancer biomarkers on MR scans or in blood. **Botwe et al (2021)**



Source: https://www.frontiersin.org/journals/artificial-intelligence/articles/10.3389/frai.2023.1227091/full

Figure 1: Use of AI in Life and Medical Field

Additionally, by making it easier to create a customized protocol for each patient and calculating radiation risks in relation to cumulative dosage, patient age, and other factors, AI may help radiologic technologists optimize doses. Artificial intelligence (AI) systems could learn to map ultralow-dose CT procedures using neural networks and recreate the images at a better quality. **Gillan et al (2021)** Ultimately, AI may help optimize everyday workflow by prioritizing inspections according to suitability standards and other variables, including emergency level. Immediately following image acquisition, AI shows potential in preprocessing procedures to enhance workflow and efficiency. **Vallée et al (2020)**

Objective of the Study

The main objective of the study is to evaluate the application and usage of Artificial intelligence in Radiology and role of radiologic technologists and radiation therapists in the same.

Research Methodology

- The study focuses on the studies conducted in the respective field from 2015 to 2024.
- Most of the studies are conducted by the scholars of KSA who have worked worldwide in the respective field.
- Only those studies were included that have the reference of AI in Radiology and bear the keywords i.e. AI, Radiology, Medical Imaging, OEM, Radiologist, etc.
- Todal 70 studies from KSA and rest of the world are included.
- 7 studies were excluded as they do not contain the recent information related to use of AI in Radiology.

AI in Radiation Therapy

In many respects, radiation therapy is at the forefront of AI developments in oncology, in part due to the use of imaging modalities for screening and diagnosis, but also because of AI-based techniques that make processes like segmentation, treatment planning, and delivery easier. AI deep learning techniques are also well-positioned to provide real-time data mining, automated image-guided adaptive therapy, and clinical decision support. **Venter et al (2023)**

➢ ***Multi-scan methods***

For planning, CT scanning is essential. Radiation therapists can use AI to obtain numerous cone beam CT (CBCT) images and combine them for matching by using neural networks. CBCT and planning CT images can be directly mapped using neural networks. Radiation therapy planning for the head and neck has been investigated using a voxel-based prediction and dose mimicking technique. Adaptive radiation therapy benefits from the capacity to quickly combine numerous scans online using deep learning to take respiratory motion into consideration. Additionally, online variables including patient positioning before to treatment, anatomical changes, and tumor response to treatment can assist in coordinating onboard imaging with the planned CT. **Coakley et al (2022)**

➢ ***Real-time fiducial tracking***

The next generation of fiducial markers may be enhanced by smart biomaterials. To put it briefly, a smart biomaterial is able to react to stimuli or changes in the body. Activation of functionalized nanoparticles can increase the efficacy of radiation therapy. Research is being done on coating or loading nanoparticles onto fiducial markers. Real-time tracking of the fiducial markers for auto beam holding can reduce harm to surrounding tissues or organs and increase treatment precision. **Walsh et al (2023)**

➢ ***Auto contouring of structures***

Improved treatment plans result from automating this task. Normal tissue and malignant areas are usually separated by hand. Treatment plans may become unclear due to the subjective and time-consuming nature of the technique, which varies depending on the operator. Earlier attempts at automating segmentation just used the information in each image; however, more recent approaches are utilizing machine learning, which incorporates prior knowledge. An AI-based system might, for instance, include data on relative anatomy or anticipated organ size fluctuations. Every image voxel's structure labeling is learned by the system, which then combines the information with previously acquired knowledge using mathematical models. For radiation therapy personnel, auto contouring can provide more standardized contouring and substitute time-consuming human labor. Additionally, image recognition, object classification, and disease detection are areas where deep learning techniques show promise. AI is expected to increase treatment monitoring, which is essential for assessing the efficacy of radiation therapy, and the efficiency of the intricate workflow of radiation therapy.

Advantages of AI

AI-based systems can handle thousands more data points faster than a human could, which is one of the technology's advantages in medicine. Learned experience serves as a basis for some of these important decisions. However, it is possible that a doctor has never seen a patient with a specific and uncommon set of clinical signs for a certain illness. AI systems have the capacity to retain and interpret far more data than a doctor's brain, which typically sees 30 patients per day, once they are able to learn. The utilization of consumer health tracking data for public health research that surpasses conventional data and capabilities is possible with internet-based health indicators. Social markers can help close any gaps in patient health and well-being data that aren't available in medical sources. AI is capable of collecting population data and combining it with information about populations and communities to enhance epidemiology and improve chronic illness management and prevention.

Provider-facing AI tools like clinical decision assistance and care coordination also contribute to positive patient experiences (Heath, 2018). AI-powered patient navigation, for instance, can sort through medical records and patient reports, saving professional patient navigators time by eliminating the need to read radiology and pathology reports. By using these technologies, navigators can save up to three hours a day that would otherwise be spent identifying patients who require cancer care navigation and waiting for navigators to start reaching out and offering assistance. In the end, more time is available for patient engagement because of the time savings. To reach a conclusion, a radiologist considers information such as the patient's medical history, past imaging, and present imaging.

AI is capable of analyzing hundreds or thousands of data points pertaining to a particular patient or imaging indicators for anomalous disease. Personalized patient treatment is therefore a compelling advantage of AI. AI-based software that makes decisions quickly can contribute to more individualized clinical care as well as more individualized radiology and radiation therapy encounters, from radiation dose and treatment plans to location. Machine learning techniques are capable of analyzing vast amounts of data pertaining to clinical and therapeutic variables for patients receiving radiation therapy. By combining imaging data with pertinent clinical, dosimetry, and tumor biology information, knowledge-based adaptive planning can enhance tumor control and minimize radiation toxicity while customizing treatment. When receiving radiation treatment for head and neck tumors, patients may lose a significant amount of weight and need feeding tubes.

Issues Related to Use of AI

The development and broad application of AI in medicine face many obstacles. Medical imaging is poised to become the largest medical discipline to use AI in patient treatment. Experts in radiation therapy and medical imaging will act as kind of pioneers in the radiologic sciences, which are at the forefront of AI developments. AI differs from earlier technological developments in that, even with its full potential, the data in a machine learning system is never entirely comprehensive or complete. Only after programming reaches a tipping point where facts either support or refute the information being queried can a machine make decisions.

Thus, while the AI apparatus may be able to process more data more quickly, it is not able to recognize that "this is all we need to know and we must decide," nor is it capable of making decisions.

Some related Issues:

a. Establishing moral standards for using patient data, handling and disclosing mistakes, and interacting with equipment. Although preliminary research has started, if AI capabilities are more completely developed and applied, ethical and liability concerns may still surface.

b. Ensuring the security and privacy of patient data at the institutional and industry levels. Concerns about data security and privacy include cybersecurity risks, data ownership and rights (such the ability to opt out or delete information), and a "for the greater good" mentality, which entails proving that a specific AI system has a need or a right to the data it gathers.

c. Formulating regulations to ensure constant patient openness about AI tools.

d. Professionals that can explain the technologies and traceable and explainable processes are needed for this purpose.

e. Additionally, policies must to continue to emphasize taking patient preferences into account. observing potential algorithmic or automated bias and its prevention or detection.

f. Creating a framework for combining AI tools with patient-specific information to prevent algorithmic bias and promote individualized care.

g. Outlining strategies for incorporating expert input from radiation therapy and medical imaging into machine learning to reduce dose creep and keep patient safety in mind.

Future Scope of Using AI

According to market forecasts made in 2020, there would be a significant increase in cutting-edge AI applications in medical imaging by 2022–2027. Early in 2020, artificial intelligence (AI) is starting to close the gap between gathering data and interpreting it in a useful way. Although it is still in its early stages, the application of AI to advanced imaging modalities like CT and MR is already showing significant potential. Examples include early results on distinguishing benign from malignant nodules on chest CT images, as well as applications in neurologic and psychiatric fields. AI integration into MR has demonstrated potential for survival prediction in patients with amyotrophic lateral sclerosis and cervical cancer. Machine learning is being considered or tested for automatic organ segmentation, treatment planning, and preventing errors in radiation therapy. It is anticipated that the application of artificial neural networks and machine learning will accelerate the exponential expansion of AI in healthcare.

Conclusion

[In the ongoing development of medical equipment that radiologic science specialists use on a daily basis, artificial intelligence is a reasonable next step. There is a chance to raise public understanding of AI and machine learning while also ensuring that patients are informed about technology. Maintaining the quality of AI-based devices and integrating AI into quality programs, especially for patient radiation dose, should be undertaken by or led by radiologic technicians and radiation therapists. Stakeholders must band together as a group to promote the ethical application of AI in accordance with established joint statements on AI in medical imaging, established codes of ethics, and the fundamentals of AI. As OEMs face strong market forces and regulatory changes, they should inform and work with radiologic technologists and radiation therapists to guide AI-relevant policies, procedures, and deep learning for AI devices. Radiologic technologists and radiation therapists should become involved in laying the groundwork for ethical, practical, patient safety, and clinical aspects of AI in their responsibilities and for the betterment of patient care. Further work is needed as industry, radiologic science professionals, and institutional leaders work together to meet the challenges of AI specific to medical imaging and radiation therapy in terms of patient data privacy, security, and patient safety."

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