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ADVICE NOTE

Artificial intelligence (AI) in radiotherapy.

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Context

Artificial Intelligence (AI) is an umbrella term coined by Prof. John McCarthy in 1955 for “the science and engineering of making intelligent machines”. This document serves to state IPEM’s position on the use of these technologies in radiotherapy at time of writing. It is noted that to date AI technology in radiotherapy overwhelmingly employs machine learning methods but that may not be the case in the future; ‘AI’ is used herein as the umbrella term. AI has seen rapid development and adoption in many sectors over the last five years, including multiple facets of healthcare. Applications of AI in radiotherapy are appealing given chronic workforce challenges [1] and the potential for automation to expedite the work of human operators. AI has many potential patient benefits. These include reducing time to treatment, reducing unwarranted variation in practices, automating repetitive tasks freeing up resources and allowing staff to focus on other important tasks and person-centred care in the pathway.

Guidance on Adoption

Before any technology is adopted into clinical practice it must be shown to be both safe and cost-effective. Depending on application, some AI is “black box” and the processing between input and output lacks transparency. In the context of radiotherapy, where high doses of radiation are delivered to the patients, there is a legal requirement for individual accountability [IR(ME)R 2017]. Therefore regulators, professional bodies and manufacturers need to work together to develop standards to demonstrate any AI application is safe, and to clearly define roles and responsibilities with respect to all particulars of the system including its development, testing, training (if applicable) and outputs. Patient representatives should be included as part of these discussions. NHSE and healthcare services of the devolved nations, NICE and professional bodies need to agree a method for determining the cost-effectiveness of AI applications where these are tools to decrease the human workforce burden. This needs to be considered in the context of the current workforce shortages in radiotherapy, the scope to redistribute resources to other weakened service areas and the improvement of staff work-life balance.

Educational Needs

AI is a relatively new technology to radiotherapy, rapidly developing and multifaceted. There is

therefore an urgent need to educate the current workforce and ensure newly qualified staff are adequately trained. Education providers and professional bodies should provide training in the theoretical principles, function and limitations of the different AI technologies to enable staff to use AI appropriately. Professional bodies should urgently develop guidance on the implementation and validation of AI technology to allow their rapid and safe adoption where the efficacy has been proven (or is in a formalised process of evidence generation). Programmes of education are required to develop experts for the evaluation and implementation of these tools into the clinical workflow. These will be responsible for the quality assurance and monitoring the performance of the AI to ensure that they are safe, effective and efficient.

Current and potential applications

AI may have beneficial applications for several aspects of the radiotherapy patient pathway:

i. Decision-to-treat and treatment regime support tools, including individualised treatment response/toxicity prediction
ii. Pre-treatment imaging enhancement, including artefact suppression and image registration
iii. Automated contouring of anatomical structures, including organs at risk and tumours
iv. Automated treatment plan optimisation
v. Automated treatment plan checking and quality assurance
vi. Enhancement of image guidance and motion management
vii. Adaptive radiotherapy decision and workflow tools
viii. Predict equipment failures, reducing machine downtime

At time of writing, little of the above have been implemented beyond the R&D space. Given the potential risks, educational requirements and rate of technology growth, early consideration of possible applications is important. There may be additional applications of AI outside of the patient pathway which fall within the scope of IR(ME)R (e.g. automated analyses of QC images and results) and some in an administrative capacity alone (e.g. appointment scheduling optimisation).

The main area of development and implementation to date has been in automated contouring. In September 2023 NICE launched Early Value Assessment guidance on the use of AI for automated contouring [2]. Several technology vendors have entered the market and, at time of writing, NHS centre uptake has been variable. IPEM is supportive of a wide, structured approach to evaluating AI technologies.

Risks and issues

All AI requires a significant amount of high quality, well-curated training data that is representative of the population being served. Without this there is a high probability of biased outputs. Developers and manufacturers of AI should state in the documentation supplied with the product the amount and range (population, temporal cut-off of data included) of data used to train the application. Any standards used to curate the data (e.g. particular international guidelines followed) must be stated in the documentation. Ideally any application should indicate the level of certainty associated with any output. This will enable users to reach well-informed decisions about the reliability of the output and aid the explicability of the output.

As the workforce adapts to having an AI assistant their skills need to be maintained. This is important to ensure staff are capable of the initial validation of the AI, be responsible for the output of the system and provide training data for model improvements.

Some thought needs to be given to innovation speed as AI becomes ubiquitous. With innovation comes the need to retrain the AI models, which requires more data. Currently if a new organ is delineated or a treatment technique is adopted, then this can be done quickly by the highly skilled staff. If the service becomes reliant on AI then the ability to innovate may be reduced, and become reliant on manufacturers producing new AI models.

Some AI tools will be best implemented using Cloud computing and the payment model will become “software as a service” (SaaS). Departments do need to consider the consequences of the potential loss of such services on either a temporary or a permanent basis. If an application is not based within an organisation and if the manufacturer ceases trading, then there could be a sudden loss access to the software. The NHS needs to ensure that its financial rules enable the use of SaaS.

It may be that “Open Source” AI tools become available. These are often seen as low cost. However, if these are to be used as medical devices, then departments need to ensure that they have been developed and registered as such. Consideration needs to be made of ensuring there are enough well trained staff to implement and support such an application. The same standards for the commercial development of AI models need to be followed for Open Source software. If this is developed locally then significant resources will be required.

The NHS needs to find mechanisms to ensure equity of access to this emerging technology. Without this there will be patchy uptake, which will limit the access of patients to the potential benefits of the technology.

The NHS should consider a form of price protection for AI technologies (similar to the NHS Drug Tariff) to ensure value for money is retained for per-patient models of payment. This will become particularly important if market competition decreases and as reliance on the technology becomes embedded.

Key conclusions and recommendations

1. IPEM supports the adoption of AI technologies where evidence exists of value for money and/or clinical advantages. Where adequate evidence does not exist, IPEM supports the trial adoption of AI technologies as part of structured evidence generation.
2. AI technologies in radiotherapy should remain tools to support (as opposed to replace) operators in performing clinical tasks for the foreseeable future.
3. Education and training providers for all radiotherapy professionals should urgently review and update their syllabi to include salient aspects of AI.
4. Radiotherapy vendors should ensure that their implementations of AI are transparent and free from bias.
5. NHSE and healthcare providers for the devolved nations should consider future-protected pricing for revenue model AI systems to ensure value for money is retained once their use is embedded in practice.
6. NHS Trusts and their commissioners must not expect dramatic short-term efficiency gains or cost savings when investing in AI technologies and must allow time for evidence generation and safe adoption.

7. Providers should, focus on evolution of staff roles, knowledge, skills and strategies to mitigate deskilling, and not seek to reduce their workforce.

[1] IPEM Radiotherapy Census Report 2021/22 (2023), Institute of Physics and Engineering in Medicine. https://www.ipem.ac.uk/media/qdajodwe/2021-radiotherapy-census-report-v2.pdf
[2] Artificial intelligence technologies to aid contouring for radiotherapy treatment planning: early value assessment, NICE. Health technology evaluation HTE11. September 2023.

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