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Artificial intelligence for equitable precision in head and neck cancer care

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Abstract

Dear Editor,I appreciate Karunya et al.'s comprehensive review of the epidemiology, global burden, and evolution of head and neck cancer radiotherapy (HNC)[1], and believe that artificial intelligence (AI) has the potential to link all of these technological advances to earlier diagnosis, more personalised treatment and more equitable access to radiotherapy. First, AI can solve some real world challenges of high quality radiotherapy planning. The use of deep-learning systems for automatic segmentation of target volumes and organs at risk (OAR), the prediction of achievable dose distributions, supporting plan optimization, and quality assurance (QA) is of particular relevance in HNC, where target volumes are often irregularly shaped and closely contiguous to the salivary glands, pharyngeal constrictors, spinal cord, brainstem, and other radiosensitive organs. In some studies, AI-driven planning has shown to save time and improve the quality of plans, while in others, it has been found to be as efficient as traditional planning, but further clinical validation is required[2]. The potential impact of AI on ART could be even more pronounced during this multiple-week course of radiotherapy, as changes in the position of the tumour, weight loss, and tumour regression can affect target coverage or the dose to normal tissue. Cone beam computed tomography enhancement or generation, automatic re-contouring, dose recalculation and identification of patients likely to benefit from replanning are all aspects of the ART pathway that can be accelerated with the help of AI. There is promising performance for AI-based OAR segmentation, models to predict the need for adaptation, and it was noted that the evidence available to date is largely retrospective, and so human review should be integral, especially for tumour boundaries and small critical structures[3]. Last, the advantages of AI-assisted ART should be measured by clinically meaningful outcomes, not just geometric precision, such as xerostomia, dysphagia, and dependence on feeding tubes, among other toxicities. Second, AI can help to enhance early detection and risk-based referral in areas with high burden. Smartphone assisted oral examination is a potentially scalable option for delayed presentation in India, where tobacco use, areca-nut consumption, alcohol consumption and lack of specialists are involved in delayed presentation. Such models could be applied to aid prioritization of oral potentially malignant disorder cases for teleconsultation or biopsy or specialist referral in Indian community screening datasets, using deep-learning algorithms applied to oral photographs acquired by trained frontline health workers[4] They need to be used as a triage tool, however, not as a stand-alone diagnostic instrument. The performance of any algorithm must be assessed in a variety of populations, devices, lighting conditions, lesion locations, and levels of health worker training and training, or otherwise, the algorithm may actually exacerbate diagnostic disparities and inequities. Limited external validation, methodological inconsistencies, and a lack of prospective studies are also identified as significant challenges in the broader HNC AI literature[5].Third, AI offers a chance to shift away from anatomy-based treatment decision. Models that take into account HPV or p16 status, smoking history, tumour subsite, imaging, digital pathology, molecular markers and longitudinal treatment data could be used to estimate locoregional control, distant failure, survival and toxicity for each individual patient. These estimates could ultimately help inform treatment-intensity decisions, biomarker-directed treatment selection criteria, surveillance planning, and biomarker-directed trial eligibility[6]. Therefore, although evidence suggests that radiomic models have moderate diagnostic

accuracy, at this time, there is not enough consistent evidence to replace the currently validated pathological HPV testing and treatment de-intensification should be reserved for appropriately designed clinical trials. More generally, models using clinical and radiomic data have yielded promising results for predicting tumour control and radiotherapy toxicity, but need larger, multi-institutional datasets and prospective validation[7]. A pathway to implementation that would be constructive would be the four following steps that would be pre-clinical “silent mode” evaluation of the software prior to use; software validation across institutions, imaging vendors, treatment platforms, and subgroups; deployment of the software with uncertainty alert systems and auditable overrides; and post-implementation monitoring for software toxicity, disease control, workflow efficiency, and subgroups performance. Resource limited centres should not be recipients of models developed in only a well-resourced centre, but should also be a co-design and validation centre. It will be critical that the software is lightweight, that it integrates easily with current CT and linear-accelerator equipment, that calibration can be completed locally, that the workforce can be trained to use it, and that its cost-effectiveness is easily understood. Federated or distributed learning can also enable collaborative model improvements, without the need to centralize sensitive patient information. The review by Karunya et al. serves as a useful framework in which to consider how responsibly validated AI may help enhance planning accuracy, the ability for adaptive treatment, improving early detection and biologically driven personalization. But “automation for the sake of automation” isn't the priority; the goal should be to deliver measurable and equitable improvements in patient outcomes.

Introduction

Dear Editor,

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Declarations

Author Contribution

All Parts Done by me

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