AI reshaping the landscape of head and neck cancer

BY ABISHEK MAHAJAN

With artificial intelligence set to transform almost every aspect of life, Abishek Mahajan reviews its potential to improve head and neck cancer care.

Artificial intelligence (AI) has emerged as a transformative tool in healthcare. In the realm of oncology, AI is playing a pivotal role in reshaping the landscape of head and neck cancer management. Head and neck cancers pose unique challenges due to their complex anatomy, intricate treatment protocols and variable outcomes. AI applications are revolutionising the way these challenges can be dealt with by offering new avenues for early detection, accurate diagnosis, personalised treatment planning, and improved patient outcomes. Here are some means by which AI and deep learning are reshaping the landscape of head and neck cancer management.

Early detection and diagnosis

Image analysis: Early detection is vital for favourable outcomes, and deep learning algorithms are being created and validated in a variety of images sourced from radiology, pathology, clinical, optical and thermal images. Some of these algorithms have demonstrated remarkable capabilities in analysing imaging data involving identification of subtle patterns and features that can be indicative of early-stage disease and aggressive tumour biology which has implications on patient outcomes.

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Prognostication and personalised treatment

Genomic data analysis: AI and computation biology is being used to analyse genomic and molecular data which is revolutionising personalised treatment planning. Deep learning algorithms can identify specific genetic mutations or biomarkers associated with worse clinical outcomes and can enable clinicians to tailor treatment, incorporating targeted therapies and immunotherapies early in the course of treatment for better outcomes.

Treatment response prediction

Predictive analytics: Predicting individual patient outcomes to various treatment modalities is critical for personalised care but is often challenging. Deep learning predictive models based on meta-data such as clinical history, imaging, pathology and genomic information can guide the treating physician to choose the most effective treatment strategies, minimising failure rates and improving overall treatment outcomes.

AI-driven surgical oncology

Augmented reality surgical suites: These suites have the potential to enable precise intraoperative 3D visualisation of tumours, aiding surgeons in accurate preplanning and executing intricate procedures seamlessly. Real-time overlays of critical anatomical structures can significantly enhance surgical accuracy, reduce complications, and optimise better surgical outcomes. The integration of AR fosters a new era in enhanced learning for surgical trainees, and personalised and innovative oncological interventions.

Radiation therapy optimisation

Dose planning: AI is significantly contributing in optimising radiation therapy. Algorithms are being created to precisely determine organs at risk, tumour volumes, and radiation dose calculation. This can ensure that the optimal dose is delivered to target areas while minimising doses to organs at risk. The application of AI in radiation oncology has the potential to ease planning, enhance treatment effectiveness and reduce the risk of radiation toxicities.

Patient monitoring and follow-up

Remote monitoring: Real-time patient monitoring facilitated by AI will be transformational in individualised care. In future, AI-powered tools will have the potential to enable remote monitoring, collecting continuous health data from patients. This will allow for the early detection of potential oncological emergencies, toxicities, treatment failures and recurrences. This can facilitate timely interventions and adjustments to treatment plans driven by feedback mechanism from current patient status.

Data integration and decision support

Electronic health record (EHR) analysis: The analysis of meta-data from electronic health records (EHRs) including radiology, pathology and lab reports is the oil to fuel AI in healthcare. Natural language processing-based analysis of clinical data, imaging and pathology reports and other unstructured text can be used to develop nomograms for predicting clinical outcomes. AI-driven data integration can help identify trends, correlations and risk factors associated with poor outcomes in head and neck cancer. This comprehensive computational analysis

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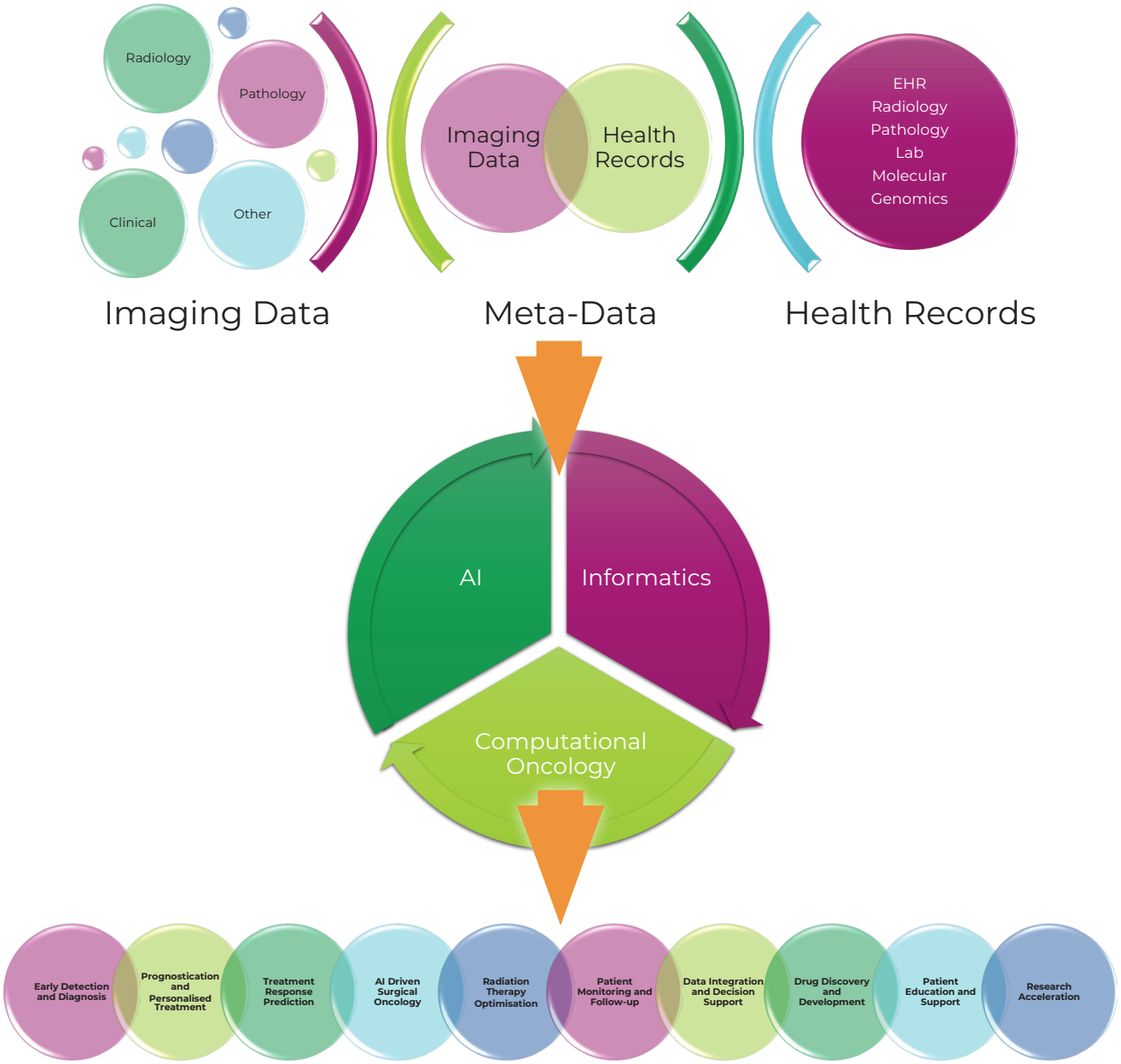

can provide invaluable decision support for healthcare providers, enhancing the overall quality of patient care and improving outcomes.

Drug discovery and development

Drug repurposing: AI can be applied to accelerate drug discovery by analysing extensive databases to identify potential drugs for repurposing in head and neck cancer treatment. This innovative approach holds promise for expanding treatment options and reducing the time and cost associated with bringing new therapies to clinical practice.

Patient education and support

Chatbots and virtual assistants: AI-driven virtual assistants could be the future of patient education and support. These kinds of virtual assistants can offer insights into the patient's condition, treatment options, and strategies for managing their care. The integration of AI in patient education will not only contribute to enhanced patient engagement but will also lead to empowerment throughout their cancer journey.

Research acceleration

Text and literature analysis: AI has the ability to analyse huge amounts of scientific literature which can accelerate research in the field of head and neck cancer. Text and literature analysis tools can sift through extensive research, aiding researchers in identifying relevant data for ongoing studies, clinical trials, systematic analysis and meta-analysis. This accelerated research pace holds the potential to drive continuous improvements in treatment modalities.

Challenges and considerations

While the integration of AI in head and neck cancer management holds immense promise, several challenges require careful consideration. Issues such as data privacy, ethical considerations, and the need for rigorous validation of AI models in clinical settings are paramount. Collaborative efforts between healthcare professionals, researchers, and AI experts are essential to ensure the responsible and effective integration of these technologies into routine clinical practice. Strategic partnership with various leading head

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and neck centres in UK and beyond is the way forward. Head and neck biobanks are needed to fuel AI tool development by providing vast repositories of biological samples. This synergy accelerates the creation of advanced algorithms for diagnostics, personalised medicine, and groundbreaking medical research.

In conclusion, deep learning and artificial intelligence are reshaping the landscape of head and neck cancer management. This comprehensive impact spans early detection, personalised treatment planning, therapy optimisation, patient monitoring and research acceleration. As these technologies continue to evolve, their responsible integration into clinical practice holds the potential to significantly improve outcomes for head and neck cancer patients. This marks a transformative era in oncology, where collaborative efforts are crucial in harnessing the full potential of AI for the benefit of patients and advancing the field of cancer care.

References

1. Cherian Kurian N, Sethi A, Reddy Konduru A, et al. A 2021 update on cancer image analytics with deep learning. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery* 2021;**11(4)**:e1410.
2. Chakrabarty N, Mahajan A. Imaging analytics using artificial intelligence in oncology: a comprehensive review. *Clin Oncol* 2023;S0936-6555(23)00334-5.
3. Mäkitie AA, Alabi RO, Ng SP, et al. Artificial Intelligence in Head and Neck Cancer: A Systematic Review of Systematic Reviews. *Adv Ther* 2023;**40(8)**:3360–80.
4. Michelutti L, Tel A, Zeppieri M, et al. The Use of Artificial Intelligence Algorithms in the Prognosis and Detection of Lymph Node Involvement in Head and Neck Cancer and Possible Impact in the Development of Personalized Therapeutic Strategy: A Systematic Review. *J Pers Med* 2023;**13(12)**:1626.
5. Mahajan A, Vaidya T, Gupta A, et al. Artificial intelligence in healthcare in developing nations: The beginning of a transformative journey. *Cancer Research, Statistics, and Treatment* 2019;**2(2)**:182-9.

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Declaration of competing interests:
None declared.