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From physics to patients: Medical physicists driving improved patient outcomes in radiation oncology

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Radiation oncology is a cornerstone of modern cancer care, with approximately 40% of patients receiving radiotherapy (RT) during their cancer journey. Central to its success is achieving an optimal therapeutic ratio: maximising tumour control while minimising side effects. Radiation oncology is a highly technical field, where new algorithm and hardware advances drive improvements in patient outcomes. Radiation oncology medical physicists are critical to this endeavour, driving innovation, ensuring safety, and enabling consistent translation of new technology into clinical practice.

At the Peter MacCallum Cancer Centre, translational research in radiation oncology encompasses a spectrum of approaches, from the adoption of novel technologies to the development of new treatment paradigms. Current projects include investigating the feasibility of novel patient positioning to expand treatment options and tolerance, exploring new techniques for delivery of radiation such as particle and synchrotrons, leveraging artificial intelligence to reduce burden of repetitive tasks, and advancing novel imaging methods to guide radiation therapy.

Clinical trials remain the key enabler in translational research. This can be achieved with ‘virtual clinical trials’ where in silico models are used to model tumour control and side effect outcomes, providing cost-effective early evidence to guide technology adoption before use in patients, or to inform clinical trial design. Clinical trials in patients however remain the gold standard in assessing the benefit of new technology on not only patient outcomes but in health economics.

Major challenges remain; aligning technological advances with meaningful patient outcomes; integrating research and learning culture into routine clinical workflows where outcome data may be sparse; and balancing cost, accessibility, and usability with efficacy. Addressing these challenges requires close collaboration between physicists, clinicians, and trialists, ensuring that cutting-edge research translates into tangible improvements in survival, quality of life, patient experience and health economics.

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