



Particle Therapy in Australia: *iacta alea est!*

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The Australian Bragg Centre for Proton Therapy and Research (ABC) has begun site preparation work (thus *iacta alea est*, the die is cast). Located in the new South Australia Health and Medical Research Institute building, construction should be complete in 2023, with accelerator installation and commissioning over the subsequent 18 months. This editorial accompanies five manuscripts

on particle therapy (PT) in this issue and records the journey to deliver PT to Australia thus far. We propose actions required to ensure optimum implementation and use of PT at the bi-national (Australian and New Zealand, ANZ) level, so patients have equitable access to evidence-based treatment from a skilled workforce to a world-class quality in a safe and effective way.

Australia's involvement in the science underpinning PT (proton beam therapy (PBT), carbon and other ion therapy) can be traced back to William Henry Bragg's 1904 research at the University of Adelaide.¹ Working with radium isotopes, Bragg and assistant William Kleeman discovered what we now term the Bragg peak. Furthermore, the concept of a synchrotron particle accelerator was first suggested in 1943 by University of Adelaide graduate, Sir Marcus Oliphant. These highlight that investment in scientific research can translate to significant benefits for healthcare outcomes and society and that Australia can be internationally leading in such areas.

The Adelaide project began in 2002 when the South Australian government funded an investigation of PBT options including a scoping of work. The ABC will house a synchrotron capable of accelerating protons to 330 MeV, although limited to 250 MeV for PBT. The beamline will be switched between one fixed beam treatment room and two rooms with gantries.

In June 2012, Australia's Nuclear Science and Technology Organisation (ANSTO) established the Australian Hadron Therapy Collaboration 'to adopt a national approach in the delivery of a convincing case for the introduction of a Hadron Therapy Clinical and Research facility to Australia', supporting the preparation of business models combining clinical, research and development, technical development, educational and economic cases for both proton and carbon ion therapy for Australian cancer patients.

In October 2015, the Royal Australian and New Zealand College of Radiologists (RANZCR) Faculty of Radiation Oncology issued a position paper on PT with two key statements that patients in ANZ must have access to PT and that the Faculty supports investigation of establishing a PT facility or facilities in ANZ which network with cancer centres nationally and internationally and treat patients according to agreed clinical protocols which incorporate long term follow up.

Over recent years, overseas jurisdictions have published patient numbers estimated to have at least some of their treatment by PT, with a high of 13–15% of all radiation therapy (RT) patients (Sweden, France, Austria, Japan) to a low of 1–2% in the United Kingdom where estimates are based on only the highest evidence level and initially limited capacity scenario.² With Australia's population hubs in the State capital cities and a need to make PBT accessible to patients, a network collaborating to progressively open PT facilities in major population centres can be justified.

As well as the ABC, there are developed business cases for PT centres in Sydney, Melbourne and Brisbane. Together these have moved towards a nationally collaborative approach to ensure consistent preparation for PT in Australia and a partnership approach to a service as it evolves.

The National Particle Treatment and Research Centre in the Westmead health and research precinct was

proposed in 2014. Led by Western Sydney Local Health District and in partnership with ANSTO, research centres and universities, a business case has been submitted to the New South Wales government. The decision was made to include carbon and other ions, as well as protons, to value-add internationally competitive physics, engineering and translational and applied research in the PT field to clinical and biology research. There are only 12 carbon ion facilities in operation worldwide currently.³

Metro North Hospital and Health Service plans to develop the Queensland Proton Therapy and Research Centre within a comprehensive cancer centre. Metro North has a fully developed business case and design incorporating four rooms, one of which will house a dedicated research beam.

The Peter MacCallum Cancer Centre, Victorian Department of Health and Human Services and the University of Melbourne were invited by the Victorian Government to develop a business case for PBT in 2016, revised in 2017. Final funding was not approved, though the state government remains committed to the provision of PT in Victoria.

The New Zealand National Radiation Oncology Plan 2017–2021 does not include the provision of PT although acknowledges that RT techniques and delivery technologies continue to develop globally and that internationally the use of PT is increasing.

The first National Particle Therapy Symposium was held in November 2017 to recognise the funding announcement for the ABC. Two subsequent annual Symposia have progressively brought together the clinical and research communities with interest in PT and wider ANZ collaborations are developing. Consumer engagement was an important component of the 3rd Symposium and educational materials will be available on the Targeting Cancer platform shortly. RANZCR, the Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM) and the Australian Society of Medical Imaging and Radiation Therapy (ASMIRT) have each established Particle Therapy Special Interest Groups since the first Symposium, as has the Trans Tasman Radiation Oncology Group (TROG Cancer Research). Through these professional bodies, a unified and collaborative partnership approach to training, education and clinical research across ANZ and across the professional groups has developed. This includes beginning to develop the expert workforce; both RANZCR and ACPSEM have supported overseas fellowships to gain PBT knowledge and build international connections.

In this issue of JMIRO, Hwang et al report two systematic reviews, one updating the clinical evidence base for PT (PBT, carbon ion therapy and other ions) and the other focussing on toxicity outcomes. Together they conclude that as a minimum, PT provides equivalent tumour outcomes compared with conventional photon controls, with evidence to support reduced morbidity and improved quality of life in a range of tumours including

head and neck cancers, paediatric tumours, sarcomas and gastrointestinal tumours. The reviews aim to inform decision-making for patient referrals to the ABC and other centres in ANZ as they become operational and for treatment overseas in the interim.

The Medical Treatment Overseas Program of the Australian Commonwealth government currently funds Australians to travel abroad for PT, although total numbers have been small for many practical reasons. Hu et al report in this issue that while 19 cases in a three-year period were submitted to MTOP after comparative dose planning (PBT versus photon therapy) performed by the Adelaide group, only 14 patients received PBT abroad. The COVID-19 pandemic means that highly suitable patients for PT will be unable to access PT for some time and highlights the need for this treatment to be available in Australia.

A survey of RANZCR fellows and trainees conducted by McNeil et al in late 2019, now reported, identified confidence in the role of PBT although noting a need to provide education about both the indications for PBT and the referral process. This is a critical task, as oncologists need to understand the role PT may play in management of their patients.

Children will form an important patient group for treatment by PBT. Murphy et al propose in this issue that a fortnightly videoconference begun by the Paediatric Radiation Oncology SIG of RANZCR has potential to act as an ANZ referral panel for children and adolescents for PBT. The benefit of pre-treatment peer review for the RT management of patients with rare tumours is also highlighted. Since many patients managed by PT will have uncommon tumours, peer review by a national PT review panel with representatives from each facility and each professional group will be an essential component of ensuring safe and world-class PT for all patients.

The PT network in ANZ aims to establish a virtual registry for all patients potentially suitable for PT. Several registries already exist internationally⁴ and the aim is to be compatible and collaborating with these. Establishing

a virtual registry capable of developing predictive models and setting up clinical trials so that every patient treated by PT in ANZ contributes to the generation of evidence for PT needs input from the whole community of RANZCR Fellows, as well as members of ACPSEM and ASMIRT. TROG is the logical co-ordinating body for a registry and for clinical research.

Until 2004, there were only two PBT facilities in the United States, whereas there are now 35 in operation, another 36 under construction and five more being planned.³ Establishment of facilities in ANZ needs rational consideration. In the proposed structure, having one national facility with carbon and other ions and three PBT centres,⁵ the ANZ resource becomes the whole combined distributed networked group of centres working collaboratively together. There is consensus that this will best develop optimised patient care, integrated clinical protocols and patient pathways and also PT research programmes of international standard, rather than compete for patients and research endeavours at the individual facility level.

References

1. Bragg WH. LXXIII. On the absorption of α rays, and on the classification of the α rays from radium. *London Edin Dublin Philos Magazine J Sci* 1904; **8**: 719–25.
2. Tsuji H. Overview of carbon-ion radiotherapy. *J Phys Conf Ser* 2017; **777**: 012032.
3. <https://www.ptcog.ch/index.php/facilities-in-operation>. Accessed 9 May 2020.
4. Langendijk JA, Orecchia R, Haustermans K *et al*. Prospective data registration and clinical trials for particle therapy in Europe. *Radiother Oncol* 2018; **128**: 9–13.
5. Thwaites DI, Sykes J, Ahern V. A practical proposal for a collaborative networked national approach to the provision of particle therapy in Australia; comparison to other countries, Proc EPSM2016. *Sydney. Australas Phys Eng Sci Med* 2016; **39**: 1068.