Particle Therapy

An advanced form of precisely-targeted radiation therapy that is improving outcomes in difficult-to-treat cancers, significantly reducing the risk of harmful, long-term side effects.

Who would benefit the most from access to this advanced form of cancer treatment?

> *The principal advantage of using proton beam therapy is reduced dose beyond the tumour target. This is most useful in younger patients where one is aiming to reduce the potential long-term side effects of radiation therapy.*
>
> **Dr Daniel Saunders**
> Clinical Oncologist, The Christie UK

Particle therapy complements conventional radiation treatments - in particular, in those patients who don't respond to established clinical approaches.

For children, teenagers, and young adults treated using conventional radiation therapy and/or radical surgeries, there is a significant risk of harmful effects to proximate tissue because of exposure to large amounts of collateral radiation.

Conventional treatments can lead to serious secondary health problems and a lifetime of ongoing invasive and expensive treatments and medications.

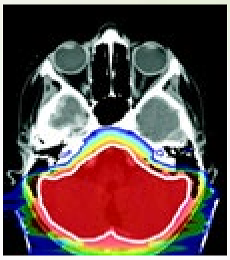
In many cases, these side effects are debilitating, and compromise quality of life.

Particle therapy is used internationally to reduce the risk of damage to critical body systems from toxicity associated with radiotherapy and chemotherapy, as well as to prevent the emergence of secondary cancers.

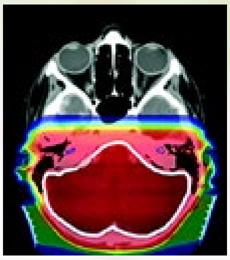
Proton therapy, a type of particle therapy, is often recommended for a range of childhood cancers and when malignancies are located close to critical organs, such as in the brain.

Particle therapy would also offer hope to patients who have cancer that do not respond to other forms of treatment.

Protons



Standard photons



Treatment with particle therapy (left) spares critical healthy cells and organs, such as the auditory system in children from radiation damage as shown in the images above.

The global landscape

Facilities in operation

Country	Proton	Carbon	Country	Proton	Carbon	Country	Proton	Carbon	Country	Proton	Carbon
Austria	1	1	France	3		Netherlands	3		South Korea	2	
Canada	1		Germany	6	2	Poland	1		Sweden	1	
China	2	3	India	1		Russia	4		Switzerland	1	
Czech Republic	1		Italy	3	1	Saudi Arabia	1		Taiwan	1	
Denmark	1		Japan	14	6	South Africa	1		USA	32	

Proton facilities **Carbon** facilities

At the end of 2018, more than 220,000 patients had been treated at particle therapy facilities around the world. There are also about 200 clinical trials taking place that involve the use of particle therapy.

Particle therapy is now available at facilities in more than 19 countries, including India and Saudi Arabia.

Particle therapy is well established in Japan, the United States, Germany, Austria and Italy, which were pioneers of the treatment and in the development of facilities. These countries now operate leading clinical centres.

While construction of the first facilities began in the 1990s, construction has escalated considerably in recent years.

There are 97 facilities that are either operational or under construction in the world today, and another 23 are planned. The United Kingdom, Denmark, Norway, and Sweden have recently built state-of-the art facilities.

Source: Particle Therapy Co-operative Group. www.ptcog.ch. 2019.

The Asia-Pacific region

The number of particle therapy facilities in the Asia-Pacific region has followed the global trend, with a significant rise in construction since 2012.

China has 18 particle therapy facilities either in operation or in the planning/construction stages. Japan, which leads the world in the use of carbon ions, has 20 particle therapy facilities in operation and a further facility under construction.

Both South Korea and Taiwan are developing additional facilities to complement those already in operation.

The United Kingdom prepared for the introduction of particle therapy by implementing a UK-based clinical assessment process prior to sending patients to a partner facility in the United States. Australia could adopt this approach and begin introducing comparative plans to assess the possibility for patients to benefit from particle therapy.

A compelling case for particle therapy in Australia

NAME	PROPOSED LOCATION	TYPE OF CENTRE	STATUS	LEADING ORGANISATION
Australian Bragg Centre for Proton Treatment and Research	Adelaide	Proton	Approved / Under construction	South Australian Health and Medical Research Institute
National Particle Treatment and Research Centre (NPTRC)	Sydney	Carbon, proton, other ions	Business case	Western Sydney Local Health District
Queensland Proton Therapy and Research Centre (QPTRC)	Brisbane	Proton	Business case	Metro North Hospital and Health Service
National Proton Beam Therapy Centre	Melbourne	Proton	Initial funding commitment	Victorian Government and Peter MacCallum Cancer Centre

SAHMRI | NSW Government Health Western Sydney Local Health District | Queensland Government Metro North Hospital and Health Service | Victoria State Government | Peter Mac Peter MacCallum Cancer Centre Victoria Australia

There are no particle therapy facilities in Australia; however, a number of proposals have been advanced to introduce the treatment here. These are shown in the table above with Australia's first proton therapy facility under construction in South Australia.

This is the first step in the creation of an integrated national particle therapy network in Australia.

Australia has a substantial base of expertise and experience in the accelerator sciences developed through many years of research and development activities undertaken at ANSTO, Australia's Nuclear Science and Technology Organisation, and Australian universities.

Additionally, Australia can take advantage of ANSTO's access to an extensive network of collaborative partners world-wide, who operate facilities and carry out research in to particle therapy.

Building on these resources, Australia could develop a national collaborative network for clinical practice and undertake education and research activities that would foster the development and use of particle therapy across Australia and our region more broadly.

> *"Australian patients must have access to particle therapy. Particle beam therapy is currently not available in Australia; however it is the faculty position that particle beam therapy is essential for some patients with evidence."*

The Royal Australian and New Zealand College of Radiologists

Consensus among stakeholders

Patients, health professionals, medical physicists and particle therapy researchers, as well as consumer advocacy groups, hospitals, research organisations, and industry partners have all acknowledged the potential benefits arising from the introduction of particle therapy to Australia.

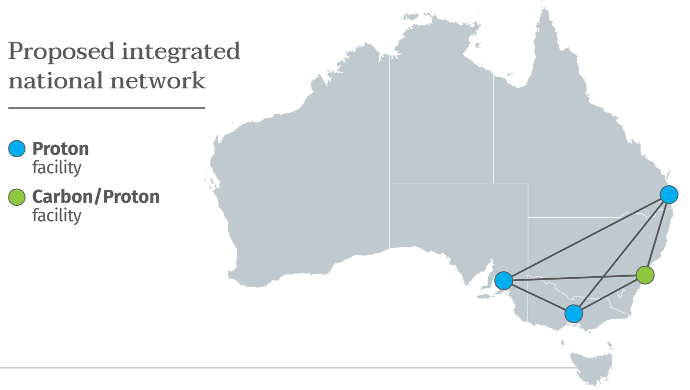
Particle therapy centres in other parts of the world have shown a generous capacity to share expertise and experience with countries considering its introduction.

ANSTO and the Australian Collaboration for Accelerator Science have long expressed interest in assisting with the introduction of particle therapy in Australia.

Several particle therapy symposiums have been held in Australia in recent years, which have attracted considerable stakeholder interest, including from consumers, government agencies, health services, research organisations, and universities from Australia, New Zealand, and overseas.

In 2019, Symposium participants re-affirmed their commitment to the introduction of particle therapy in Australia.

Proposed integrated national network



A challenging situation for Australian cancer patients who need particle therapy

The need for Australia to invest in innovative, translational research is essential to the task of reducing the growing impact of cancer and its financial burden on the health care system.

Cancer is the major cause of illness and a leading cause of death in Australia. One in two Australians will develop a malignancy in their lifetime and one in five will die from cancer before the age of 85.

In 2019, it is estimated that approximately 145,000 Australians will be diagnosed with cancer and more than 49,000 will die from a malignancy.

While the overall five-year survival rate from all cancers has reached 69%, survival rates for individual cancers vary, and there are cancers that are inoperable or for which there are no current treatment options in Australia.

Approximately 800 Australian patients per year will benefit initially, with the number likely to rise over time as the treatment is expanded to patients with different treatment needs as knowledge and capacity evolves.

More than 4500 Australian patients each year could benefit.

Based on international patient numbers and evidence, demand is expected to rise to over 4500 patients per year in subsequent years. This increase is due to a number of factors, including expanding the list of clinical indications in line with emerging protocols and an increase in the referral of patients by oncologists as the technology becomes more widely utilised through the development of comparative treatment plans.

With no particle therapy facilities in Australia, the Australian Government currently spends, on average, $140,000 per person when sending a patient for particle therapy treatment overseas through the Medical Treatment Overseas Program.

The price for treatment of external patients at overseas facilities (not including travel, living, and accommodation costs) can vary between $60,000 to more than $200,000 per patient, depending on the type and length of treatment required.

Currently, the number of patients sent overseas is very low, due to tight restrictions on acceptance into the Program.

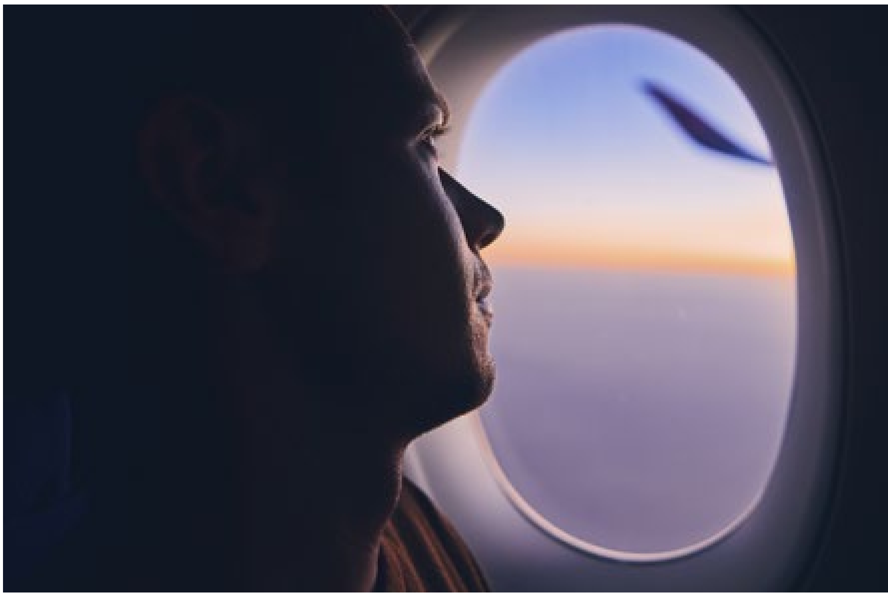
As well as demonstrating a significant advantage for particle therapy against conventional treatment, patients must be well enough to fly overseas for an extended duration and able to tolerate a delay in the commencement of their treatment while their application is processed.

It also must be demonstrated that there will be a good chance of success (potentially curative) with particle therapy.

With an aging population this demand is expected to increase further. Planning is needed now.

> *"In addition to a shorter treatment period, benefits of particle therapy to patients include reduced pain and minimal other symptoms during and after treatment, which enables people to continue to resume normal life more quickly."*

Prof Hirohiko Tsujii
Director of the Particle Radiotherapy Consultation Clinic in Chiba, Japan



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Capabilities in particle therapy can bring benefits to clinical research, science and industry

Clinical research

In addition to treating patients, particle therapy technologies can drive internationally-competitive clinical research to improve cancer care and outcomes. This includes clinical trials, radiation dosimetry and the development of technology and practices for next-generation particle therapy.

Aerospace and space

Advanced accelerator technologies can support investigations into the impact of radiation on people and equipment in aerospace and space environments. It has been highly useful in the development of radiation detectors and radiation hard materials. The particle accelerators used in particle therapy also have lots of potential for new research in particle physics, astrophysics and cosmology studies.

Electronics

Accelerated ion beams can be used to assist in the manufacture of electronic components and used to assess the robustness of advanced electronic integrated circuits. Developments from the advancements required for particle therapy facilities mean that faster, higher accuracy and more intelligent control systems are developed to improve patient outcomes, which can then be spun off and implemented in other technologies.

Advanced materials

Irradiation with high energy ion beams open the potential to fabricate materials with novel properties, such as membranes with nano-scale holes for molecular filtration, and etching grooves or structures in silicon or glass. Ion beam technology is also needed in testing resistance to radiation hardness in materials and in challenging environments, such as encountered in new energy applications, including fusion.

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Cancer in Australia 2019 Australian Institute of Health and Welfare.