Australian Government

Department of Health

Application Form

Proton beam therapy for paediatric and rare cancers

(Amended Request for Public Funding)

(Version 2.4)

This application form is to be completed for new and amended requests for public funding (including but not limited to the Medicare Benefits Schedule (MBS)). It describes the detailed information that the Australian Government Department of Health requires to determine whether a proposed medical service is suitable.

Please use this template, along with the associated Application Form Guidelines to prepare your application. Please complete all questions that are applicable to the proposed service, providing relevant information only. Applications not completed in full will not be accepted.

Should you require any further assistance, departmental staff are available through the Health Technology Assessment Team (HTA Team) on the contact numbers and email below to discuss the application form, or any other component of the Medical Services Advisory Committee process.

Email: hta@health.gov.au
Website: www.msac.gov.au

PART 1 – APPLICANT DETAILS

1. Applicant details (primary and alternative contacts)

Corporation / partnership details (where relevant):
Corporation name: South Australian Health and Medical Research Institute Limited
ABN: 54 141 228 346
Business trading name: South Australian Health and Medical Research Institute Limited

Primary contact name: [redacted]

Primary contact numbers
Business: [redacted]
Mobile: [redacted]
Email: [redacted]

Alternative contact name: [redacted]

Alternative contact numbers
Business: [redacted]
Mobile: [redacted]
Email: [redacted]

2. (a) Are you a lobbyist acting on behalf of an Applicant?

☐ Yes
☒ No

(b) If yes, are you listed on the Register of Lobbyists?

☐ Yes
☐ No

PART 2 – INFORMATION ABOUT THE PROPOSED MEDICAL SERVICE

3. Application title

Proton beam therapy for paediatric and rare cancers.

4. Provide a succinct description of the medical condition relevant to the proposed service (no more than 150 words – further information will be requested at Part F of the Application Form)

The proposed service is relevant to adults and children diagnosed with the certain cancer types. These are typically cancers of the central nervous system and in proximity to the axial skeleton. Proton beam therapy is particularly advantageous for paediatric and Adolescent and Young Adult (AYA) patient groups as it reduces the amount of radiation delivered to normal healthy tissue during the course of radiotherapy. This can have an impact on long term outcomes for these patients.

Proton beam therapy has also been utilized for certain rare adult cancer types such as chordoma, chondrosarcoma and adenocarcinoma of the salivary and lacrimal glands. For these radioresistant cancers, proton beam therapy can be utilized to increase radiation dose to the cancer while maintaining a lower or equivalent dose to surrounding normal tissues when compared to conventional radiotherapy. Potential dose reductions to surrounding tissues may also decrease the incidence of adverse events and the risk of complications.

5. Provide a succinct description of the proposed medical service (no more than 150 words – further information will be requested at Part 6 of the Application Form)

Proton beam therapy is a form of external beam radiotherapy. It consists of a high energy particle accelerator, beam transport lines, rotating gantry structures, robotic patient positioning systems, and X-ray image guidance systems. The particle accelerator technology produces protons of a specific energy to be delivered to a cancer site within the body. The rotating gantry allows the proton beam to be delivered at various angles around the body. X-ray image guidance ensures the proton radiation is delivered to the intended location in the body.

The proton radiation interacts with patient tissues to damage DNA, inducing cell death. This is the equivalent mechanism by which conventional radiotherapy with X-rays works. Proton radiation allows for a greater differential in the radiation dose delivered to the tumour relative to surrounding healthy tissue than conventional radiotherapy with X-rays.

6. (a) Is this a request for MBS funding?

☒ Yes
☐ No

(b) If yes, is the medical service(s) proposed to be covered under an existing MBS item number(s) or is a new MBS item(s) being sought altogether?

☐ Amendment to existing MBS item(s)
☒ New MBS item(s)

(c) If an amendment to an existing item(s) is being sought, please list the relevant MBS item number(s) that are to be amended to include the proposed medical service:

Not applicable.

(d) If an amendment to an existing item(s) is being sought, what is the nature of the amendment(s)?

i. ☐ An amendment to the way the service is clinically delivered under the existing item(s)
ii. ☐ An amendment to the patient population under the existing item(s)
iii. ☐ An amendment to the schedule fee of the existing item(s)
iv. ☐ An amendment to the time and complexity of an existing item(s)
v. ☐ Access to an existing item(s) by a different health practitioner group
vi. ☐ Minor amendments to the item descriptor that does not affect how the service is delivered

vii. ☐ An amendment to an existing specific single consultation item
viii. ☐ An amendment to an existing global consultation item(s)
ix. ☐ Other (please describe below):

(e) If a new item(s) is being requested, what is the nature of the change to the MBS being sought?

i. ☐ A new item which also seeks to allow access to the MBS for a specific health practitioner group
ii. ☒ A new item that is proposing a way of clinically delivering a service that is new to the MBS (in terms of new technology and / or population)
iii. ☐ A new item for a specific single consultation item
iv. ☐ A new item for a global consultation item(s)

(f) Is the proposed service seeking public funding other than the MBS?

☐ Yes
☒ No

(g) If yes, please advise:

Insert description of other public funding mechanism here

7. What is the type of service:

☒ Therapeutic medical service
☐ Investigative medical service
☐ Single consultation medical service
☐ Global consultation medical service
☐ Allied health service
☐ Co-dependent technology
☐ Hybrid health technology

8. For investigative services, advise the specific purpose of performing the service *(which could be one or more of the following)*:

Not applicable.

i. ☐ To be used as a screening tool in asymptomatic populations
ii. ☐ Assists in establishing a diagnosis in symptomatic patients
iii. ☐ Provides information about prognosis
iv. ☐ Identifies a patient as suitable for therapy by predicting a variation in the effect of the therapy
v. ☐ Monitors a patient over time to assess treatment response and guide subsequent treatment decisions

9. Does your service rely on another medical product to achieve or to enhance its intended effect?

☐ Pharmaceutical / Biological
☒ Prosthesis or device
☐ No

Both proton beam therapy and conventional radiotherapy require computed tomography imaging for the process of treatment planning. This activity is captured as an item number in the current application. Also, a course of cancer treatment may include chemotherapy or immunotherapy in addition to radiotherapy. The same pharmaceutical agents would be used in proton beam therapy as conventional radiotherapy.

10. (a) If the proposed service has a pharmaceutical component to it, is it already covered under an existing Pharmaceutical Benefits Scheme (PBS) listing?

Not applicable

☐ Yes
☐ No

(b) If yes, please list the relevant PBS item code(s):

Not applicable

(c) If no, is an application (submission) in the process of being considered by the Pharmaceutical Benefits Advisory Committee (PBAC)?

☐ Yes (please provide PBAC submission item number below)
☐ No

Not applicable

(d) If you are seeking both MBS and PBS listing, what is the trade name and generic name of the pharmaceutical?

Not appliable

Trade name: Insert trade name here
Generic name: Insert generic name here

11. (a) If the proposed service is dependent on the use of a prosthesis, is it already included on the Prostheses List?

Not applicable

☐ Yes
☐ No

(b) If yes, please provide the following information (where relevant):

Not applicable

Billing code(s): Insert billing code(s) here
Trade name of prostheses: Insert trade name here
Clinical name of prostheses: Insert clinical name here
Other device components delivered as part of the service: Insert description of device components here

(c) If no, is an application in the process of being considered by a Clinical Advisory Group or the Prostheses List Advisory Committee (PLAC)?

Not applicable.

☐ Yes
☐ No

(d) Are there any other sponsor(s) and / or manufacturer(s) that have a similar prosthesis or device component in the Australian market place which this application is relevant to?

Not applicable.

☐ Yes
☐ No

(e) If yes, please provide the name(s) of the sponsor(s) and / or manufacturer(s):

Insert sponsor and/or manufacturer name(s) here

12. Please identify any single and / or multi-use consumables delivered as part of the service?

Single use consumables (treatment course consumable):

- Patient immobilisation devices
  - Vacuum bags
  - Head and neck masks
- Bolus for skin dose
- Patient skin markers
- Contrast agent for planning CT

Multi-use consumables:

- Gowns
- Table sheets

PART 3 – INFORMATION ABOUT REGULATORY REQUIREMENTS

13. (a) If the proposed medical service involves the use of a medical device, in-vitro diagnostic test, pharmaceutical product, radioactive tracer or any other type of therapeutic good, please provide the following details:

Type of therapeutic good: Proton beam therapy system
Manufacturer's name: [redacted]
Sponsor's name: South Australian Health and Medical Research Institute Limited

(b) Is the medical device classified by the TGA as either a Class III or Active Implantable Medical Device (AIMD) against the TGA regulatory scheme for devices?

☐ Class III
☐ AIMD
☒ N/A

14. (a) Is the therapeutic good to be used in the service exempt from the regulatory requirements of the *Therapeutic Goods Act 1989*?

☐ Yes (If yes, please provide supporting documentation as an attachment to this application form)
☒ No

(b) If no, has it been listed or registered or included in the Australian Register of Therapeutic Goods (ARTG) by the Therapeutic Goods Administration (TGA)?

☐ Yes (if yes, please provide details below)
☒ No

ARTG listing, registration or inclusion number: Insert ARTG number here
TGA approved indication(s), if applicable: Insert approved indication(s) here
TGA approved purpose(s), if applicable: Insert approved purpose(s) here

15. If the therapeutic good has not been listed, registered or included in the ARTG, is the therapeutic good in the process of being considered for inclusion by the TGA?

☐ Yes (please provide details below)
☒ No

Date of submission to TGA: Insert date of submission here
Estimated date by which TGA approval can be expected: Insert estimated date here
TGA Application ID: Insert TGA Application ID here
TGA approved indication(s), if applicable: If applicable, insert description of TGA approved indication(s) here
TGA approved purpose(s), if applicable: If applicable, insert description of TGA approved purpose(s) here

16. If the therapeutic good is not in the process of being considered for listing, registration or inclusion by the TGA, is an application to the TGA being prepared?

☒ Yes (please provide details below)
☐ No

Estimated date of submission to TGA: 1/7/2020
Proposed indication(s), if applicable: Solid tumours
Proposed purpose(s), if applicable: Cancer treatment

Please see attachments for FDA approval of device, and a letter outlining communication with TGA to date.

PART 4 – SUMMARY OF EVIDENCE

17. **Provide an overview of all key journal articles or research published in the public domain related to the proposed service that is for your application (limiting these to the English language only).** ***Please do not attach full text articles, this is just intended to be a summary.***

Study design	Title of journal article	Description	Website link	Date of publication
Studies identified from previous systematic reviews	**-**	**-**	**-**	**-**
Adult brain, spinal and soft tissue	-	-	-	-
Retrospective case series	Molina 2014. Outcomes following attempted en bloc resection of cervical chordoma in the C-1 and C-2 region versus the subaxial region: a multi-institutional experience	Patients with cervical chordoma from the cervical spine Six patients were treated with PBT and overall survival was measured. PBT patients were groups with patients also receiving IMRT (n=3) and compared to patients receiving surgery alone.	https://www.ncbi.nlm.nih.gov/pubmed/24926926	2014
Retrospective cohort study	Mima 2014. Particle therapy using carbon ions or protons as a definitive therapy for patients with primary sacral chordoma	Patients with primary sacral chordomas treated with PBT (n=7) or carbon ion therapy (n=16). Outcomes assessed include local recurrence, acute and late dermatitis, myositis, neuropathy.	https://www.ncbi.nlm.nih.gov/pubmed/24288399	2014
Retrospective review	Rotondo 2015. High-dose proton-based radiation therapy in the management of spine chordomas: outcomes and clinicopathological prognostic factors.	Patients with thoracic, lumbar ad sacrococcygeal chordomas treated with PBT with surgery and BT without surgery. Outcomes assessed included local control.	https://www.ncbi.nlm.nih.gov/pubmed/26340383	2015
Single centre, prospective study	Indelicato 2016. Prospective outcomes study of proton therapy for chordomas and chondrosarcomas of the spine	Patients with chordomas or chondrosarcomas of the spine treated with postoperative PBT (n=xx) or xx	https://www.ncbi.nlm.nih.gov/pubmed/27084648	2016

Study design	Title of journal article	Description	Website link	Date of publication
Retrospective matched comparative study	Adeberg 2017. Sequential proton boost after standard chemoradiation for high-grade glioma	Patients with high grade glioma treated with bimodal photon/proton therapy (n=66) or conventional radiotherapy (n=66) and followed over 15 months. Outcomes assess include acute toxicities, intracranial pressure, decreased fine motor skills, seizure, visual deficits, transient hemiparesis, pseudo progression, worsened pre-existing symptoms.	https://www.ncbi.nlm.nih.gov/pubmed/29050959	2017
Retrospective review	Bronk 2018. Analysis of pseudo progression after proton or photon therapy of 99 patients with low grade and anaplastic glioma	Patients with Grade II and III glioma treated with PBT (n=4) or IMRT (n=65) follow-up of 24 months.	https://www.ncbi.nlm.nih.gov/pubmed/29594248	2018
Retrospective review	Gunther 2017. Imaging changes in paediatric intracranial ependymoma patients treated with proton beam radiation therapy compared to intensity modulated radiation therapy	Leukemia/lymphoma patients with CNS involvement before stem cell transplant. Outcomes include mucositis during CSI or transplantation, viral and bacterial infections, gastrointestinal toxicity, CNS/neurotoxicity and cardiovascular toxicities.	https://www.ncbi.nlm.nih.gov/pubmed/26279024	2017
Retrospective review	Mozes 2017. Volumetric response of intracranial meningioma after photon or particle irradiation	Patients with meningioma treated with proton or mixed therapy (n=38) or IMRT or fractioned therapy (n=39) follow-up of 12-24 months. Outcome of tumour volume.	https://www.ncbi.nlm.nih.gov/pubmed/27911139	2017
Retrospective database review	Jhaveri 2018. Proton vs. photon radiation therapy for primary gliomas: an analysis of the National Cancer Database.	Patients with Grade 1-4 glioma treated with PBT (n=170) or photon XRT (n=49,405). Measuring overall survival with a median follow-up of 62.1 months.	https://www.ncbi.nlm.nih.gov/pubmed/30547008	2018
Retrospective cohort study	Brown 2013. Proton beam craniospinal irradiation reduces acute toxicity for adults with medulloblastoma	Patients with medulloblastoma treated with PBT (n=19) or photon radiotherapy (n=21), median follow-up of 26 and 57 months, respectively. Outcomes include	https://www.ncbi.nlm.nih.gov/pubmed/23433794	2013

Study design	Title of journal article	Description	Website link	Date of publication
		locoregional failure, weight loss, nausea/vomiting, medical management of esophagitis, IV fluid support, bone marrow suppression, anaemia, haematologic toxicity.		
Retrospective cohort study	Hug 2000. Proton radiation therapy for chordomas and chondrosarcomas of the skull base	Patients with meningioma treated with combined photon and proton therapy (n=16) or photon therapy alone (n=15). Outcomes include local control rates, target doses, distant metastasis.	https://www.ncbi.nlm.nih.gov/pubmed/11082173	2000
Retrospective cohort study	Kahn 2011. Long-term outcomes of patients with spinal cord gliomas treated by modern conformal radiation techniques	Patients with primary spinal chord gliomas treated with PBT (n=10) or photon therapy (n=22). Outcomes include local recurrences, time progression, radiation dose.	https://www.ncbi.nlm.nih.gov/pubmed/20947265	2011
Retrospective cohort study	Mizumoto 2013. Reirradiation for recurrent malignant brain tumor with radiotherapy or proton beam therapy. Technical considerations based on experience at a single institution.	Patients with recurrent malignant brain tumours treated with PBT (n=9) or photon radiotherapy (n=8)/ SRT (n=10). Outcomes measured include local recurrences and radiation necrosis.	https://www.ncbi.nlm.nih.gov/pubmed/23824106	2013
Paediatric brain, spinal and soft tissue cancers	-	-	-	-
Retrospective comparative study	Bishop 2014. Proton beam therapy versus conformal photon radiation therapy for childhood craniopharyngioma: multi-institutional analysis of outcomes, cyst dynamics, and toxicity.	Paediatric craniopharyngioma patients treated with PBT (n=21) or IMRT (n=31) over a median of 59.6 months follow-up. Outcomes assessed include OS, disease progression, early and late toxicities, endocrinopathies, panhypopituitarism, deviation in baseline vision, vascular toxicities (myoma, stroke, vessel, malformations), hypothalamic obesity.	https://www.ncbi.nlm.nih.gov/pubmed/25052561	2014

Study design	Title of journal article	Description	Website link	Date of publication
Prospective cohort study	Yock 2014. Quality of life outcomes in proton and photon treated pediatric brain tumor survivors .	Paediatric patients with CNS tumours treated with PBT (n=57) or XRT (n=63). HRQoL using the PedsQL assessment was measured at a median follow-up of 3 years.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4288853/	2014
Prospective cohort study	Song 2014. Proton beam therapy reduces the incidence of acute haematological and gastrointestinal toxicities associated with craniospinal irradiation in pediatric bran tumors.	Paediatric patients with CNS tumours treated with PBT (n=30) or photon CSI (n=13) at a median follow-up of 22 months. Outcomes assessed include CTCAE graded acute toxicities, changes in haematological parameters, thrombopoietin levels.	https://www.ncbi.nlm.nih.gov/pubmed/24913151	2014
Retrospective analysis	Gunther 2015. Imaging changes in pediatric intracranial ependymoma patients treated with proton beam radiation therapy compared to intensity modulated radiation therapy.	Children with nonmetastatic intracranial ependymoma who received post-operative PBT (n=37) or IMRT (n=35) were followed for a median of 40.6 months. Outcomes assessed include recurrence rate, treatment related CNS injury, toxicities	https://www.ncbi.nlm.nih.gov/pubmed/26279024	2015
Multi-institutional cohort study	Eaton 2016a. Clinical outcomes among children with standard -risk medulloblastoma treated with proton and photon radiation therapy.: a comparison of disease control and overall survival	Paediatric patients with standard risk medulloblastoma treated with PBT and chemotherapy (n=45) and photon therapy (n=43). Outcomes assessed include OS, RFS, tumour recurrence, patterns of failure	https://www.ncbi.nlm.nih.gov/pubmed/26700707	2016
Propensity score adjusted analysis	Eaton 2016b. Endocrine outcomes with proton and photon radiotherapy for standard risk medulloblastoma	Paediatric patients with standard risk medulloblastoma treated with PBT and chemotherapy (n=40) and photon therapy (n=37) followed over 3 years. Outcomes assed include incidence of hypothyroidism, GHD, Adrenal insufficiency, sex hormone deficiency, precocious puberty, endocrine replacement therapy, changes in height and BMI	https://www.ncbi.nlm.nih.gov/pubmed/26688075	2016

Study design	Title of journal article	Description	Website link	Date of publication
Retrospective review	Sato 2017. Progression-free survival of children with localised ependymoma treated with intensity-modulated radiation therapy or proton-beam radiation therapy.	Paediatric patients with newly diagnosed localised intracranial ependymomas treated with PBT (n=41) or IMRT (n=38) with a median follow-up of 2.4 and 4.9 years, respectively. Outcomes assessed include PFS< OS, local recurrences, toxicities.	https://www.ncbi.nlm.nih.gov/pubmed/28267208	2017
Retrospective cohort study	Kahalley 2016. Comparing intelligence quotient after treatment with proton versus photon radiation therapy for pediatric brain tumors.	Paediatric patients with brain tumours treated with PBT (n=90) or XRT (n=60) assessed for change in IQ	https://www.ncbi.nlm.nih.gov/pubmed/26811522	2016
Retrospective cohort study	Kahalley 2019. Prospective, longitudinal comparison of neurocognitive change in pediatric brain tumor patients treated with proton radiotherapy versus surgery only.	Paediatric patients with brain tumours treated with Proton CSI (n=22), proton focal (n=31) or surgery (n=40) assessed for change in IQ up to 6 years post treatment	https://www.ncbi.nlm.nih.gov/pubmed/30753584	2019
Retrospective cohort study	Kopecky 2017. Outcomes and patterns of care in a nationwide cohort of pediatric medulloblastoma: factors affecting proton therapy utilization.	Paediatric patients with medulloblastoma identified via a national cancer database and treated with either PBT (n=117) or IMRT (n=57). Survival outcomes measured at a median follow-up of 4.5 years.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5707421/	2017
Retrospective review	Paulino 2018. Ototoxicity and cochlear sparing in children with medulloblastoma: proton vs. photon radiotherapy	Paediatric patients with medulloblastoma treated with passively scattered protons (n=38) or photons (n=46) at a median follow-up of 6 and 66 months, respectively. Grade 3 and 4 hearing loss was measured use a variety of scales.	https://www.ncbi.nlm.nih.gov/pubmed/29373195	2018
Single centre, retrospective review	Bielamowicz 2018. Hypothyroidism after craniospinal irradiation with proton or photon therapy in patients with medulloblastoma	Paediatric patients with medulloblastoma due to irradiation of the hypothalamic-pituitary axis or the thyroid gland treated with PBT (n=41) or XRT (n=54) at a median follow-up of 4.7 and 10.1 years,	https://www.ncbi.nlm.nih.gov/pubmed/30537887	2018

Study design	Title of journal article	Description	Website link	Date of publication
		respectively. The risk of hypothyroidism was assessed.		
Paediatric other	-	-	-	-
Retrospective review	Sethi 2014. Second nonocular tumors among survivors of retinoblastoma treated with contemporary photon and proton radiotherapy	Paediatric patients with retinoblastoma treated with PBT (n=55) or photon therapy (n=31) assessing rates of secondary malignancies at a median follow-up of 6.9 years.	https://www.ncbi.nlm.nih.gov/pubmed/24122173	2014
Single centre, retrospective review	Grant 2015. Proton versus conventional radiotherapy for pediatric salivary gland tumors: acute toxicity and dosimetric characteristics	Paediatric patients with salivary gland tumours treated with PBT (n=12) or XRT (n=11) over a median follow-up of 8 and 35 months, respectively. Grade II and III toxicities, including, dermatitis, dysphagia, otitis extrema and mucositis were compared.	https://www.ncbi.nlm.nih.gov/pubmed/26232128	2015
Retrospective review	Agarwal 2016. The Evolution of Radiation Therapy for Retinoblastoma: The MD Anderson Cancer Center Experience	Children with retinoblastoma treated with PBT (n=16) or photon or electron radiotherapy (n=31) with a median follow up of 8 years. The long-term complications recorded include cataracts, vitreous haemorrhage, radiation retinopathy, change in visual acuity, strabismus	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6871642/	2016
Studies identified in updated literature search	**-**	**-**	**-**	**-**
Adult brain, spinal and soft tissue	-	-	-	-
Retrospective cohort study	Alterio 2020. Mixed-beam approach in locally advanced nasopharyngeal carcinoma: IMRT followed by proton	Adults with locally advanced nasopharyngeal cancer treated with mixed IMRT and PBT (n=27) or IMRT alone (n=17)	https://www.ncbi.nlm.nih.gov/pubmed/32090645	2020

Study design	Title of journal article	Description	Website link	Date of publication
	therapy boost versus IMRT-only. Evaluation of toxicity and efficacy			
Prospective clinical trial	Baumann 2019. A prospective clinical trial of proton therapy for chordoma and chondrosarcoma: Feasibility assessment	Patients with chordoma and chondrosarcoma treated with PBT (n=6) or PBT + IMRT (n=14). Outcomes assessed include QoL, fatigue local control and PFS.	https://www.ncbi.nlm.nih.gov/pubmed/31111502	2019
Retrospective cohort study	Baumann 2020. Comparative Effectiveness of Proton vs Photon Therapy as Part of Concurrent Chemoradiotherapy for Locally Advanced Cancer	Patients with non-metastatic locally advanced cancer	https://www.ncbi.nlm.nih.gov/pubmed/31876914	2020
Paediatric brain, spinal and soft tissue cancers	-	-	-	-
Prospective comparative study	Hasimoto 2019. Clinical experience of craniospinal intensity-modulated spot-scanning proton therapy using large fields for central nervous system medulloblastomas and germ cell tumours in children, adolescents, and young adults	Paediatrics with medulloblastoma and germ cell tumours treated with intensity modulated proton craniospinal irradiation (CSI) (n=9) or photon CSI (n=8). Patients experienced a lower incidence of serious acute haematological toxicity than patients treated with photon CSI.	https://www.ncbi.nlm.nih.gov/pubmed/31111946	2019
Prospective comparative study	Kahalley 2020. Superior Intellectual Outcomes After Proton Radiotherapy Compared With Photon Radiotherapy for Pediatric Medulloblastoma	Paediatric patients with medulloblastoma treated with PBT (n=37) or XRT (n=42). Outcomes included global IQ, perceptual reasoning, working memory, processing speed.	https://ascopubs.org/doi/abs/10.1200/JCO.19.01706	2020
Comparative study	Peterson 2019. Working memory and processing speed among pediatric brain tumour patients treated with photon or proton beam radiation therapy	Paediatric patients with brain tumours treated with PBT (n=2) or photon therapy (n=17). Working memory and processing speed were assessed over 24 months post treatment.	https://www.tandfonline.com/doi/abs/10.1080/02739615.2018.1510330?journalCode=hchc20	2019

Study design	Title of journal article	Description	Website link	Date of publication
Systematic reviews	-	-	-	-
Health Technology Assessment	Skelly, Andrea C., Erika D. Brodt, Naomi Schwartz, Aaron JR Ferguson, and Shelby Kantner. "Proton Beam Therapy–Re-review." (2019).Washington State Healthcare Authority	Review of the safety and efficacy of PBT, as a primary or as a salvage therapy (i.e., for recurrent disease or failure of initial therapy), for the treatment of multiple cancer types as well as selected noncancerous conditions in adults and children.	https://www.hca.wa.gov/assets/program/proton-beam-therapy-rr-final-report-20190418.pdf	2019
Health Technology Assessment	Kim, Joanne, C. Wells, S. Khangura, C. Alexander, S. Mulla, K. Farrah, M. Paulden et al. "Proton Beam Therapy for the Treatment of Cancer in Children and Adults: A Health Technology Assessment." (2017).Canadian Agency for Drugs and Technologies in Health	Review of the effectiveness, safety and cost-effectiveness of PBT for the treatment of cancer in children and adults	https://www.cadth.ca/proton-beam-therapy-treatment-cancer-children-and-adults	2017

** Categorise study design, for example meta-analysis, randomised trials, non-randomised trial or observational study, study of diagnostic accuracy, etc.*

***Provide high level information including population numbers and whether patients are being recruited or in post-recruitment, including providing the trial registration number to allow for tracking purposes.*

**** If the publication is a follow-up to an initial publication, please advise.*

18. Identify yet to be published research that may have results available in the near future that could be relevant in the consideration of your application by MSAC (limiting these to the English language only). *Please do not attach full text articles, this is just intended to be a summary.*

Type of study design*	Title of research (including any trial identifier if relevant)	Short description of research (max 50 words)**	Website link to research (if available)	Date***

** Categorise study design, for example meta-analysis, randomised trials, non-randomised trial or observational study, study of diagnostic accuracy, etc.*

***Provide high level information including population numbers and whether patients are being recruited or in post-recruitment.*

****Date of when results will be made available (to the best of your knowledge).*

PART 5 – CLINICAL ENDORSEMENT AND CONSUMER INFORMATION

19. **List all appropriate professional bodies / organisations representing the group(s) of health professionals who provide the service (please attach a statement of clinical relevance from each group nominated):**

    Royal Australian and New Zealand College of Radiologists

    Australasian College of Physical Scientists and Engineers in Medicine

    Australian Society of Medical Imaging and Radiation Therapy

    Cancer Nurses Society of Australia

    As the professional bodies were contacted as part of the consultation for MSAC 1455, we have not attached a statement of clinical relevance to this application.

20. **List any professional bodies / organisations that may be impacted by this medical service (i.e. those who provide the comparator service):**

    Royal Australian and New Zealand College of Radiologists

    Australasian College of Physical Scientists and Engineers in Medicine

    Australian Society of Medical Imaging and Radiation Therapy

    Cancer Nurses Society of Australia

21. **List the consumer organisations relevant to the proposed medical service (please attach a letter of support for each consumer organisation nominated):**

    Cancer Council Australia

    Cancer Voices Australia

    CanTeen

22. **List the relevant sponsor(s) and / or manufacturer(s) who produce similar products relevant to the proposed medical service:**

    Ion Beam Applications

    Varian

    Hitachi

    Mevion

    Sumitomo

23. **Nominate two experts who could be approached about the proposed medical service and the current clinical management of the service(s):**

    Name of expert 1: [redacted]

    Telephone number(s): [redacted]

    Email address: [redacted]

    Justification of expertise: [redacted]

    Name of expert 2: [redacted]

    Telephone number(s):

    Email address: [redacted]

    Justification of expertise: [redacted]

PART 6 – POPULATION (AND PRIOR TESTS), INTERVENTION, COMPARATOR, OUTCOME (PICO)

PART 6a – INFORMATION ABOUT THE PROPOSED POPULATION

This application makes use of the PICO Confirmation of MSAC 1455.

24. Define the medical condition, including providing information on the natural history of the condition and a high level summary of associated burden of disease in terms of both morbidity and mortality:

Proton beam therapy can be used in the treatment of benign and malignant neoplasms. In line with the PICO confirmation of MSAC 1455, this application applies to paediatric tumours and rare adult tumours of the head and spine.

A summary of the major tumours in the paediatric and adolescent and young adult (AYA) population that may benefit from proton beam therapy include:

- CNS tumours
- Retinoblastoma
- Soft tissue sarcomas in close proximity to the axial skeleton (including rhabdomyosarcomas)
- Craniopharyngioma
- Intracranial germ cell tumours
- Neuroblastoma
- Nephroblastoma

A summary of the major rare adult tumours of the head and spine that may benefit from proton beam therapy include:

- Brain tumours
- Base of skull tumours including chordoma, chondrosarcoma and meningioma
- Spine/paraspinal tumours including chordoma, chondrosarcoma and meningioma
- Ocular melanoma
- Adenoid cystic carcinoma of the salivary or lacrimal gland

The majority of these cancer types are derived from genetic origins, as opposed to environmental or lifestyle factors. The morbidity associated with a given cancer is heavily dependent on the location, stage and grade of the cancer. All conditions listed above have extremely high fatality rates if left untreated.

25. Specify any characteristics of patients with the medical condition, or suspected of, who are proposed to be eligible for the proposed medical service, including any details of how a patient would be investigated, managed and referred within the Australian health care system in the lead up to being considered eligible for the service:

It is proposed that all paediatric and AYA patients presenting with a solid tumour in the head, neck or trunk of the body would be eligible for proton beam therapy funding through Medicare.

For the adult population, it is proposed that patients presenting with a solid tumour of the brain, orbital region, base of skull and spine would be eligible for proton beam therapy funding through Medicare.

The proposed population is comprised of a heterogeneous group of diseases; however, all stand to benefit from the reduced toxicity profile of proton beam therapy. As such, clinical judgement may be exercised on a case-by-case basis to determine whether proton beam therapy would be beneficial relative to conventional X-ray therapy for a given patient of the above populations. This judgement should be based on multidisciplinary team input. The importance of the multidisciplinary team in initial assessment, diagnosis and making decisions about treatment is strongly endorsed by clinical guidelines. A multidisciplinary approach is preferred, involving pathologists, radiologists, surgeons, radiation therapists, medical oncologists and paediatric oncologists, with experience in the tumour type, and within reference networks sharing expertise and treating a high number of patients annually.

Patients not located in proximity to a proton beam therapy centre may be referred to their local consulting Radiation Oncologist who may then submit the patient for inclusion at a multidisciplinary National Proton Therapy Referral meeting. Guidance on this referral pathway is being prepared by the Royal Australian and New Zealand College of Radiologists.

Patients located in proximity to a proton beam therapy centre may be discussed at internal multidisciplinary meetings.

26. Define and summarise the current clinical management pathway *before* patients would be eligible for the proposed medical service (supplement this summary with an easy to follow flowchart [as an attachment to the Application Form] depicting the current clinical management pathway up to this point):

Patients may present to their local general practitioner displaying symptoms. The GP may then refer the patient for diagnostic investigation, typically medical imaging or biopsy. If the investigation shows the possibility of a medical condition outlined in Question 24, the GP may refer the patient to an appropriate specialist (surgeon, paediatric oncologist, medical oncologist or radiation oncologist).

Following an initial consult with the specialist, the patient will typically be discussed at a local multidisciplinary meeting to determine the optimal treatment strategy. If radiotherapy is to be included in the consensus treatment strategy, the patient will be referred to a consulting radiation oncologist.

Currently, public funding for proton beam therapy is only available through the Medical Treatment Overseas Program (MTOP). For an individual to access MTOP funding, their case must be reviewed by a panel of experts. A component of the review is a comparison of calculated radiotherapy dose distributions generated with proton beam and X-ray beam machine models. If the individual case is deemed to be eligible for MTOP funding, the patient will be approved for financial support of treatment carries out overseas. When a proton beam therapy centre becomes operational in Australia, MTOP funding will no longer be accessible for proton beam therapy.

Flowcharts showing the current and proposed clinical management pathway are included as an attachment. These are reproduced from the MSAC 1455 application.

PART 6b – INFORMATION ABOUT THE INTERVENTION

27. Describe the key components and clinical steps involved in delivering the proposed medical service:

Proton beam therapy is a multi-stage process:

1. **Initial consult** with radiation oncologist to outline prognosis and risks associated with treatment and obtain informed consent.
2. **Treatment prescription**. Clearly defined instructions for the radiation dose prescription of treatment.
3. **Radiotherapy simulation scan**. Typically performed with X-ray computed tomography, however research is investigating the use of magnetic resonance imaging for RT simulation imaging.
4. **Treatment planning**. Making use of the tomographic imaging acquired in the previous step, treatment planning involves the following steps
    a. **Target contouring**. Delineation of the target tissues performed by the consulting radiation oncologist.
    b. **Organ at risk contouring**. Delineation of normal tissue structures in proximity to the target tissue or that may experience radiation dosage.
    c. **Treatment optimization**. Optimization of the treatment machine parameters to ensure a prescription dose can be delivered to the target tissues while minimizing dose to normal tissues. Performed by a radiation therapist.
    d. **Treatment plan review**. Performed by radiation oncologist.
5. **Quality assurance.** Ensuring that the treatment plan parameters are correct for the specific patients' treatment. Performed by radiation therapists and medical physicists.
6. **Treatment delivery.** Ensuring the geometry of the treatment plan is replicated through visual and X-ray imaging means. Delivering the treatment plan on the treatment machine. Performed by radiation therapists. A treatment course may consist of approximately 30 treatment delivery sessions (typically once per day).

7. **Treatment verification.** Independent review of the imaging acquired at the time of treatment to ensure the patient was set-up correctly.
8. **Follow-up consultations**. Monitoring of patient outcomes and documentation during course of treatment and after. Performed by radiation oncologists or cancer nurses.

28. Does the proposed medical service include a registered trademark component with characteristics that distinguishes it from other similar health components?

No. All proton therapy systems are comparable in technology.

29. If the proposed medical service has a prosthesis or device component to it, does it involve a new approach towards managing a particular sub-group of the population with the specific medical condition?

Proton beam therapy is an alternative way of delivering external beam radiotherapy (EBRT). In Australia EBRT is currently delivered with X-rays generated by electron linear accelerators.

30. If applicable, are there any limitations on the provision of the proposed medical service delivered to the patient (i.e. accessibility, dosage, quantity, duration or frequency):

Proton beam therapy centres require a large capital expenditure. Because of this, there will be a limited number of centres in Australia. Currently there is only public funding for one centre in Adelaide. However, the Adelaide centre has been designed with a capacity of approximately 700 patients per year. This far exceeds the estimated incidence of patients with the conditions shown in Question 24 of approximately 150-200 per year.

Many patients will be required to travel interstate or intercity to receive proton beam therapy. This will require utilization of existing cross-border funding agreements and patient transport schemes.

31. If applicable, identify any healthcare resources or other medical services that would need to be delivered <u>at the same time</u> as the proposed medical service:

In certain cases, concurrent chemotherapy or immunotherapy may be required at the time of proton beam therapy. This will require patient management by a medical oncologist. The specific chemotherapy or immunotherapy regimen will be dependent on the cancer type.

For young patients, oversight by a paediatric medical oncologist may be required, additionally simulation and treatment delivery sessions may require general anaesthetic to ensure the patient remains still during the scan and delivery of the radiation beam. This requires a paediatric anaesthetic team.

Allied health professionals such as dieticians, play therapists, physiotherapists and/or clinical psychologists are also often engaged during a course of treatment to assist the patient in maintaining a healthy lifestyle and manage side-effects of treatment.

32. If applicable, advise which health professionals will primarily deliver the proposed service:

As outlined in Question 27, delivery of proton beam therapy is a multidisciplinary undertaking consisting of Radiation Oncologists, Radiation Therapists, Medical Physicists and Cancer Nurses.

33. If applicable, advise whether the proposed medical service could be delegated or referred to another professional for delivery:

Proton beam therapy can only be delivered by the health practitioners listed in Question 32.

34. If applicable, specify any proposed limitations on who might deliver the proposed medical service, or who might provide a referral for it:

The professional bodies representing Radiation Oncologists, Radiation Therapists and Radiation Oncology Medical Physicists are currently defining the training and qualification requirements to perform proton beam therapy.

Referral to proton beam therapy will be limited to the same professionals who currently refer to conventional radiotherapy.

35. If applicable, advise what type of training or qualifications would be required to perform the proposed service, as well as any accreditation requirements to support service delivery:

The professional bodies representing Radiation Oncologists, Radiation Therapists and Radiation Oncology Medical Physicists are currently defining the training and qualification requirements to perform proton beam therapy.

36. (a) Indicate the proposed setting(s) in which the proposed medical service will be delivered (select ALL relevant settings):

- ☐ Inpatient private hospital (admitted patient)
- ☐ Inpatient public hospital (admitted patient)
- ☒ Private outpatient clinic
- ☒ Public outpatient clinic
- ☐ Emergency Department
- ☐ Private consulting rooms - GP
- ☐ Private consulting rooms – specialist
- ☐ Private consulting rooms – other health practitioner (nurse or allied health)
- ☐ Private day surgery clinic (admitted patient)
- ☐ Private day surgery clinic (non-admitted patient)
- ☐ Public day surgery clinic (admitted patient)
- ☐ Public day surgery clinic (non-admitted patient)
- ☐ Residential aged care facility
- ☐ Patient's home
- ☐ Laboratory
- ☐ Other – please specify below

Specify further details here

(b) Where the proposed medical service is provided in more than one setting, please describe the rationale related to each:

Proton beam therapy may be delivered at either a public of private outpatient clinic, depending on the operator of the service.

37. Is the proposed medical service intended to be entirely rendered in Australia?

- ☒ Yes
- ☐ No – please specify below

PART 6c – INFORMATION ABOUT THE COMPARATOR(S)

38. Nominate the appropriate comparator(s) for the proposed medical service, i.e. how is the proposed population currently managed in the absence of the proposed medical service being available in the Australian health care system (including identifying health care resources that are needed to be delivered at the same time as the comparator service):

External beam X-ray therapy will be the comparator for this application.

39. Does the medical service (that has been nominated as the comparator) have an existing MBS item number(s)?

☒ Yes (please list all relevant MBS item numbers below)
☐ No

15555, 15565, 15275, 15715

40. Define and summarise the current clinical management pathway/s that patients may follow *after* they receive the medical service that has been nominated as the comparator (supplement this summary with an easy to follow flowchart [as an attachment to the Application Form] depicting the current clinical management pathway that patients may follow from the point of receiving the comparator onwards, including health care resources):

Following a course of conventional radiotherapy, a patient may be scheduled for a number of follow-up appointments to monitor clinical outcomes of treatment. The number of follow-up appointments and their frequency is determined by individual radiotherapy departments.

41. (a) Will the proposed medical service be used in addition to, or instead of, the nominated comparator(s)?

☐ In addition to (i.e. it is an add-on service)
☒ Instead of (i.e. it is a replacement or alternative)

(b) If instead of (i.e. alternative service), please outline the extent to which the current service/comparator is expected to be substituted:

It is expected that all patients within the PICO population would be eligible for proton beam therapy and as such, would not receive external beam X-ray therapy. While all patients may be eligible, it is likely that a proportion of patients will elect not to travel to the limited number of proton therapy centres and will receive external beam X-ray therapy.

42. Define and summarise how current clinical management pathways (from the point of service delivery onwards) are expected to change as a consequence of introducing the proposed medical service, including variation in health care resources (Refer to Question 39 as baseline):

In general, the clinical management pathway following a course of proton beam therapy is not intended to differ from that of the comparator. The patient will be scheduled for a series of follow-up appointments with a radiation oncologist or cancer nurse. Because a large number of patients will have travelled interstate or intercity to receive proton beam therapy, the follow-up appointments will likely make use of telehealth infrastructure.

Providing consent is obtained from the patient, all follow-up data will be entered into a data registry. It is intended that all patients will have follow-up data acquired for a minimum of 5 years, and substantially longer for paediatric and AYA patients.

PART 6d – INFORMATION ABOUT THE CLINICAL OUTCOME

43. Summarise the clinical claims for the proposed medical service against the appropriate comparator(s), in terms of consequences for health outcomes (comparative benefits and harms):

When delivered at the same prescribed tumour dose as the comparator, proton beam therapy delivers less radiation to the healthy tissue of the patient than the comparator. In these cases, proton beam therapy has a superior safety profile than the comparator.

When delivered with the same tolerance dose to healthy tissues as the comparator, proton beam therapy may be able to deliver higher doses to the tumour volume than the comparator. In these cases, proton beam therapy has a superior efficacy profile than the comparator. Potential dose reductions to surrounding tissues may also decrease the incidence of adverse events and the risk of complications.

44. Please advise if the overall clinical claim is for:

☒ Superiority
☒ Non-inferiority

Superiority in safety for paediatric patients.
Superior or non-inferior for adult populations depending on the individual case.

45. Below, list the key health outcomes (major and minor – prioritising major key health outcomes first) that will need to be specifically measured in assessing the clinical claim of the proposed medical service versus the comparator:

Safety Outcomes:

Paediatric intracranial cancer patients:

Reduced neurocognitive impairment

Reduced neuro-endocrine impairment

Reduced likelihood of second cancer induction from treatment

Paediatric extracranial cancer patients:

Reduced acute toxicity resulting from treatment (type of toxicity dictated by site of cancer)

Reduced likelihood of second cancer induction from treatment

Adult patients:

Reduced short-term toxicities

Clinical Effectiveness Outcomes:

Adult patients:

Increased local control for patients who can achieve dose escalation to the tumour in relative to the comparator

PART 7 – INFORMATION ABOUT ESTIMATED UTILISATION

46. Estimate the prevalence and/or incidence of the proposed population:

Approximately 100-150 paediatric patients and 50 adult patients per year across Australia. Up-to-date incidence data for this PICO population is being retrieved through the Australian Institute of Health and Welfare. This information will be utilized in the Health Technology Assessment Report.

47. Estimate the number of times the proposed medical service(s) would be delivered to a patient per year:

A patient would be expected to undergo one treatment course of proton therapy in a year. Each treatment course consists of approximately 33 treatment sessions, on average, with a treatment session typically delivered 5 days per week for a period of 6 weeks.

48. How many years would the proposed medical service(s) be required for the patient?

Treatments are intended to be one-time events. However, if recurrence of the disease or progression to other sites occurs, the patient may be eligible for further treatment courses.

49. Estimate the projected number of patients who will utilise the proposed medical service(s) for the first full year:

Approximately 100.

50. Estimate the anticipated uptake of the proposed medical service over the next three years factoring in any constraints in the health system in meeting the needs of the proposed population (such as supply and demand factors) as well as provide commentary on risk of 'leakage' to populations not targeted by the service:

Full uptake (~150-200 patients) from the proposed population is anticipated within the first 3 years.

Data suggests proton beam therapy is at least non-inferior to external beam X-ray therapy for other common cancers. These patients may be treated with the service, but until clinical trial data is completed, we do not expect these patients to be covered by Medicare. Future applications for MBS funding will be based on the results of local or international clinical trials.

PART 8 – COST INFORMATION

51. Indicate the likely cost of providing the proposed medical service. Where possible, please provide overall cost and breakdown:

A detailed cost breakdown will be provided in the Health Technology Assessment Report. Costs shown below are initial estimates based on the current IMRT radiotherapy MBS item structure; however, it is assumed that on average, more experienced staff are required to deliver proton beam therapy than IMRT. Thus, the cost of proton beam therapy is approximately 3.0 times the cost of an equivalent course of IMRT. The cost model will be refined in the Health Technology Assessment Report.

Activity	**IMRT**	**PBT** **without and (with) anaesthetic**
Simulation	$721.90	[redacted]
Treatment planning	$3,366.85	[redacted]
Treatment delivery (per fraction)	$185.85	[redacted]
Treatment verification (per fraction)	$77.85	[redacted]
Total - 33 fraction treatment	$12,790	[redacted]

Note: the extra expense with anaesthetic is to account for the extra PBT staff time required to perform the task, not for anaesthetic staff or consumables which is covered by separate item numbers.

52. Specify how long the proposed medical service typically takes to perform:

There are a number of stages to the delivery of proton therapy.

1. **Treatment simulation with CT or MRI**

   Typical appointment time: 30 mins – 1 hour (without anaesthetic)

   Typical appointment time: 1 hour – 2 hour (with anaesthetic)

2. **Contouring**

   Typical time: 4 hours – 8 hours

3. **Treatment planning**

   Typical time: 8 hours – 12 hours

4. **Treatment plan review**

   Typical time: 1 hour

5. **Treatment plan quality assurance**

   Typical time: 2 hours – 4 hours

6. **Treatment session**

   Typical time: 20 mins – 30 mins (without anaesthetic)

   Typical time: 45 mins – 1:15 hour (with anaesthetic)

7. **Treatment verification**

   Typical time: 30 mins

8. **Treatment course (~33 sessions)**

   Typical time: 1 session per weekday for 6 weeks

53. If public funding is sought through the MBS, please draft a proposed MBS item descriptor to define the population and medical service usage characteristics that would define eligibility for MBS funding.

The proposed item descriptors are aligned with the Oncology Clinical Committee Medicare Benefits Schedule Review.

Category 3 – XXXXXX
Megavoltage Level 6 - Proton Beam Therapy Simulation & Planning (a) Simulation for PROTON BEAM RADIOTHERAPY, if: i. Patient set-up and immobilisation techniques are suitable for reliable image volume data acquisition and reproducible IMPT treatment; and ii. A high-quality three dimensional or four dimensional image volume dataset is acquired in treatment position for the relevant region of interest to be planned, treated and verified (through daily planar or volumetric image guidance strategies); and iii. The image-set must be suitable for fusion or co-registration with diagnostic quality datasets and generation of quality digitally reconstructed radiographic images to all complex IMPT, and (b) Dosimetry for proton beam therapy if: i. The complex IMPT delivery planning process is required to calculate dose to single or multiple target structures and requires a dose-volume histogram to complete the planning process; and ii. The complex IMPT delivery planning process maximises the differential between target dose, organs at risk and normal tissue dose, based on review and assessment by a radiation oncologist; and iii. All gross tumour volume, clinical targets volumes, planning targets volumes and organs at risk must be rendered; and iv. Organs at risk must be nominated as planning dose goals or constraints; and v. Dose calculations and dose-volume histograms must be generated in a complex inverse-planned process, using a specialised calculation algorithm, with prescription and plan details approved and recorded with the plan; and vi. Three dimensional image volume dataset must be used for the relevant region to be planned, treated and verified; and vii. Relevant multi-modality diagnostic imaging (imaging including four-dimensional CT, contrast-enhanced CT, magnetic resonance imaging and positron emission tomography is used to delineate all relevant targets and organs at risk; and viii. Images are suitable for generation of quality digitally reconstructed radiographic images; and ix. The final dosimetry plan is validated by both the appropriately qualified radiation therapist and/or medical physicist, using robust quality-assurance processes, with the plan approved by the radiation oncologist prior to delivery, which must include: A. Determination of accuracy of dose fluence delivered by the pencil beam scanning system and gantry position (static or dynamic); or B. Ensuring the plan is deliverable, data transfer is acceptable and validation checks are completed on a proton therapy system; or C. Validation of accuracy of the derived IMPT treatment plan; and x. Only one ADDITIONAL dosimetry plan (for re-planning/adaptive strategy) every 5 treatment fractions is payable through the MBS during the treatment course (at 50% of the fee for this item), when treatment adjustments are inadequate to satisfy treatment protocol requirements.

Category 3 – XXXXXX
Megavoltage Level 6 – Proton Beam Therapy Treatment & Verification, Treatment Strategies Proton beam therapy and verification, using a device approved by the Therapeutic Goods Administration if: (a) Image-guided radiation therapy imaging is used (with motion management functionality if required) to implement a complex IMPT, prepared in accordance with item 15XXX; and (b) Complex IMPT delivery mode is utilised (delivered by a fixed or dynamic gantry proton therapy delivery system); and image decisions and actions are documented in the patient's record; and (c) Payable once only for each attendance at which treatment is given (with two attendances only paid if another site is located in a different organ/part of the body and requires treatment on the same day), and (d) Daily treatment verification is included in the MBS fee, and patient-specific IMPT quality assurance applied to all cases, with one ADDITIONAL IMPT plan/adaptive strategy payable per 5 fractions (at 50% of the fee for item 15XXX) when treatment adjustments are inadequate to satisfy treatment protocol requirements.

In items 15XXX and 15YYY: Inverse Planned Proton Beam Therapy is localised through 3D or 4D volumetric imaging to identify Clinical and Planning Targets, Organs at Risk and Normal Tissue (and tumour/OAR excursion in the case of 4D applications). Planning includes optimisation of the dose based on assessment of OAR doses. This technique involves very sharp dose gradients adjacent to both targets and organs at risk increasing the consequences of any geometric uncertainty, making daily treatment verification (IGRT) an essential component of quality IMPT. In the case of 4D applications, treatment delivery utilises some form of motion management (gating, deep inspiration breath hold, rescanning etc.) and further complicates the planning, delivery and quality assurance processes. It is the tumour location, size, adjacent organs and dosimetry that define the appropriate role for IMPT, and support an approach where the clinical circumstances rather than specific diagnoses are the most important determinants for using IMPT. Patient specific pretreatment Quality Assurance will be required and consideration for re-planning/adaption is included.

Delivery Technologies: Proton accelerator based fixed beam IMPT, Proton accelerator based IMPT with a gantry

Grouped Elements: 3D or 4D Simulation/IMPT Planning. Daily Verification, Pre-Treatment QA and 1 x Re-planning/Adaption event per 5 days of treatment.